EVERYONE HAS AN UNMANNED AIRCRAFT: THE CONTROL, DECONFLICTION AND COORDINATION OF UNMANNED AIRCRAFT IN THE FUTURE BATTLESPACE

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DONALD C. CALLAGHAN, MAJOR, USAF
M.S., Embry-Riddle Aeronautical University, Daytona Beach, FL, 2002

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Unmanned aircraft (UA) today are among the most rapidly growing weapons systems in the Department of Defense (DoD). Over the past decade, technology has enabled the inherent advantages of the UA to be brought to the battlespace. Successful employment of UA across the spectrum of military operations with multiple roles and missions have left little doubt as to their value to military forces. Their success has spurred numerous efforts to continue to increase its military capabilities. This process has brought about a significant rise in the types and numbers of UA. While the increase is intended to assist military forces, the sheer numbers of existing and programmed UA assets could render military airspace chaotic and potentially dangerous. The growth of the UA is arguably outpacing the doctrinal and procedural efforts to manage them. Joint and Service doctrine and procedures provide the architecture within which joint forces will control, deconflict, and coordinate these assets. The UA is an extremely important element in current and future military operations, but they must be managed properly to ensure their safe and effective employment. Anything less will adversely affect the military's ability to operate successfully across the spectrum of operations.

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Approved by:

____, Thesis Committee Chair
Lieutenant Colonel Richard V. Warren III, M.S.

____, Member
Alexander M. Bielakowski, Ph.D.

____, Member
Charles D. Vance, M.S.

Accepted this 15th day of June 2007 by:

____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

EVERYONE HAS AN UNMANNED AIRCRAFT: THE CONTROL, DECONFLICTION. AND COORDINATION OF UNMANNED AIRCRAFT IN THE FUTURE BATTLESPACE, by Major Donald C. Callaghan, 104 pages.

Unmanned aircraft (UA) today are among the most rapidly growing weapons systems in the Department of Defense (DoD). Over the past decade, technology has enabled the inherent advantages of the UA to be brought to the battlespace. Successful employment of UA across the spectrum of military operations with multiple roles and missions have left little doubt as to their value to military forces. Their success has spurred numerous efforts to continue to increase its military capabilities. This process has brought about a significant rise in the types and numbers of UA. While the increase is intended to assist military forces, the sheer numbers of existing and programmed UA assets could render military airspace chaotic and potentially dangerous. The growth of the UA is arguably outpacing the doctrinal and procedural efforts to manage them. Joint and Service doctrine and procedures provide the architecture within which joint forces will control, deconflict, and coordinate these assets. The UA is an extremely important element in current and future military operations, but they must be managed properly to ensure their safe and effective employment. Anything less will adversely affect the military’s ability to operate successfully across the spectrum of operations.

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ACRONYMS

A2C2	Army Airspace Command and Control
ACA	Airspace Control Authority
ACM	Airspace Coordinating Measures
ACO	Airspace Control Order
ACP	Airspace Control Plan
ADAM	Air Defense Airspace Management
AGL	Above Ground Level
AO	Area of Operations
ASOC	Air Support Operations Center
ATO	Air Tasking Order
BAE	Brigade Aviation Element
BCD	Battlefield Coordination Detachment
BCT	Brigade Combat Teams
C2	Command and Control
CA	Coordinating Altitude
COP	Common Operational (or Operating) Picture
CRC	Control and Reporting Center
DoD	Department of Defense
FCS	Future Combat System
HIMEZ	High Altitude Missile Engagement Zone
ID	Infantry Division
IFF	Identification Friend or Foe
ISR	Intelligence, Surveillance, and Reconnaissance

JAOC	Joint Air and Space Operations Center
JARN	Joint Air Request Network
JFACC	Joint Forces Air Component Commander
JFC	Joint Force Commander
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
SUAS	Small Unmanned Aircraft System
SUAV	Small Unit Unmanned Aerial Vehicle
TACS	Theater Air Control System
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
U.S.	United States

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CHAPTER 1

INTRODUCTION

> We are entering an era in which unmanned vehicles of all kinds will take on greater importance in space, on land, in the air, and at sea.[1]
>
> President George W. Bush, Address to the Citadel, 2001

> Airspace is becoming increasingly and dangerously congested in the skies over Iraq and Afghanistan. The result could decrease the effectiveness of the UAV fleet, or worse, result in the loss of our own soldiers in a tragic midair collision. I worry about that C-130 or Chinook full of soldiers. It wouldn't take much for a UAV to take that down.[2]
>
> Lieutenant General Walter E. Buchanan III,
> CENTAF Commander, 2005

Background

Unmanned aircraft (UA) and their military potential were envisioned long before the technology existed to produce them. Technological advances in aircraft design, computing and data processing, circuit miniaturization, sensors, and weapons have merged to provide an aircraft no longer dependent on a human occupant. The absence of a human from these aircraft allows them to use more of their available airframe space for combat payload, rather than for a crew and its requisite life support systems. UA can also operate with much greater endurance than a human occupant would permit. Whether giving a military unit real time reconnaissance or providing persistent stand-off weapons delivery, the unmanned aircraft system (UAS) has evolved from a simple concept into the most rapidly growing intelligence and weapons platform in the Department of Defense

(DoD) and is a true success story. Today, it is being used in a variety of roles for military forces that grow ever more reliant on its emerging capabilities.

The UA was born out of military necessity. Its lack of a human occupant ideally suits it for missions that are "dull, dirty, or dangerous." Man still continues to fly such missions today because of either tradition or technological inadequacies.[3] Dull: in 1999, when B-2 crews flew 30-hour roundtrip missions from Whiteman Air Force Base, Missouri, to strike targets in Serbia in support of Operation Allied Force, the commanders' primary concern was fatigue management, not enemy air defenses. Dirty: the Air Force and Navy used unmanned B-17s and F6Fs, respectively, during nuclear weapon development in the mid-1940s to collect radioactive samples within minutes of a nuclear bomb detonation. Clearly, this mission was ill suited for a manned aircraft. Dangerous: reconnaissance has historically been a dangerous mission; 25 percent of reconnaissance pilots were lost over North Africa per mission during World War II as compared to 5 percent per mission of the bomber crews over Germany.[4] This mission typically requires longer loiter times than strike missions, and therefore a longer vulnerability period to enemy defenses. Dull, dirty, and dangerous missions continue today and will remain necessary in future warfare.

The Services need UA because, in some cases, they are preferable to manned aircraft. UA can accomplish the dull missions because machines do not have an issue with sustained alertness; the dirty and the dangerous because the human and political cost is lower if the mission is not successful, while simultaneously increasing the probability that it will be.[5] These realities are strong motivators for continued expansion and proliferation of UA.

Military forces have long sought the unique capabilities of UA. As indicated in the preceding description, the history of UA is not limited to the last several years. The earliest recorded use of an unmanned aerial vehicle (UAV) for warfighting purposes occurred in 1849 when Austria attacked Venice, Italy, with unmanned balloons loaded with explosives.[6] Some were launched by ship and others from ground stations. While some of the balloons worked as intended, others blew back across Austrian lines. UA were operated in a similar fashion during the American Civil War. Both the Union and Confederate Armies attached explosives to balloons, launched them in the direction of enemy forces and, upon landing and detonation, intended for them to inflict casualties and damage.[7] Almost one hundred years later, a similar attempt was made by the Japanese Imperial Forces during World War II. They targeted the West Coast of the United States (U.S.) with incendiary balloons.[8] Although innovative, none of these attempts had any substantial military merit. Quite simply, the users could not control them once they were launched, so their effectiveness was very limited. As a result, these early UA ideas were abandoned.

During World War II, the U.S. experimented with a weaponized UA of its own. Operation Aphrodite involved a fully-armed B-17 which was crewed by a pilot and co-pilot from takeoff until reaching a cruising altitude.[9] The pilots would then bail-out after relinquishing control to a command ship which operated the bomber via radio control. The unmanned bomber was then flown into its target. This concept was perhaps more a precursor to the cruise missile than the UAS operated today. For definition purposes, UA refers only to the aircraft itself, while UAS includes the entire system that comprises it--

aircraft, sensors, operator(s), ground control station, data collection facility, and associated support. In addition, for purposes of this thesis, UAV is synonymous with UA.

The need for UA was highlighted during critical events of the Cold War as well. pilot vulnerability made world headlines in May of 1960, when Francis Gary Powers was shot down in a U-2 over the Soviet Union. In 1962, the U.S. lost a second U-2 during the Cuban Missile Crisis.[10] These high-value, manned aircraft losses underscored the need to reduce pilot risk and the potential political fallout associated with their capture or death. As a result, the first operational UAS was developed, the AQM-34 Lightning Bug.

During the Vietnam War, the AQM-34 flew over 3,000 sorties and returned successfully nearly 90 percent of the time.[11] The Lightning Bug was operated mainly for photographic reconnaissance, but was the first UAS to include electronic intelligence, communications intelligence, and psychological operations among its missions. As technology provided greater capability, the missions of UA increased. The Bug introduced a spectrum of militarily significant uses of UA in a combat environment. The drawbacks of the Bug were that its missions required detailed pre-mission planning, and it operated without the ability to retask it once airborne.

The evolution of the UAS continued in Operations Desert Shield and Desert Storm. The U.S. Navy and Marine Corps used the RQ-2 Pioneer to support naval gunfire and for battle damage assessment.[12] Pioneers were also used to search for enemy minefields and potential landing areas of coalition amphibious assaults. In all, the Pioneer flew over 1,000 hours on more than 300 sorties in these operations. The Pioneer perhaps made its greatest contribution--and biggest headlines--when Iraqi troops, who

acknowledged it as the precursor to naval gunfire, surrendered to one of them by waving white flags and garments at it.[13]

The UAS continued its battlespace presence during Operation Allied Force in 1999. The MQ-1 Predator was debuted, providing near-persistent intelligence, surveillance, and reconnaissance (ISR) for coalition forces during combat operations in Kosovo.[14] The Predator's role has continued to expand, including being the first modern UA to be weaponized. The Predator's design was extremely successful and, as a result, it now has several versions of varying sizes, capabilities, and users.

Operations Enduring Freedom and Iraqi Freedom (OIF) have been witness to a battlespace filled with a wide spectrum of UA. The UAS now operates at all levels of war, from the strategic with the very large and very high altitude RQ-4 Global Hawk, which will replace the U-2, to the small unit tactical level with the small unmanned aerial vehicle (SUAV), such as the Raven, which can be carried on a Soldier's back.

The success of applying UASs to tactical problems over the last several years has been resounding. This revolution in military operations has spurred tremendous UA acquisition efforts by all the services, especially the U.S. Army and Air Force. This tremendous expansion can best be illustrated by their increase in flying hours since 1996 (see figure 1).[15]

This sharp increase in UA flight hours continues to climb at an exponential rate today and is the result of more overall systems, more UA users, more widespread fielding, increased mission sets, and larger platforms capable of longer flights. UA now vary greatly in size and capability depending on their intended missions and users'

requirements. Technological progression and platform variation continues to fuel UAS proliferation.

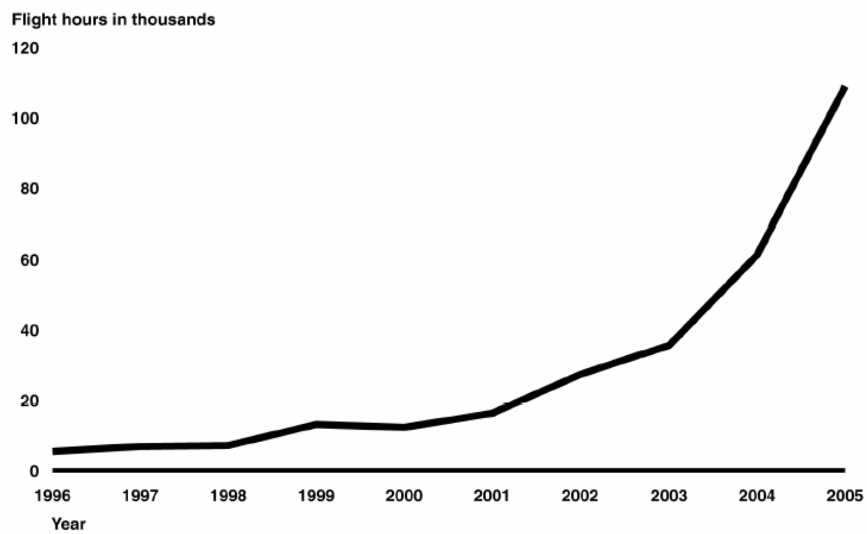

Figure 1. Unmanned Aircraft Flight Hours, 1996-2005
Source: U.S. Government Accountability Office, GAO-06-610T, *Unmanned Aircraft Systems: Improved Planning and Acquisition Strategies Can Help Address Operational Challenges* (Washington, DC: GPO, 2006), 7.

The Army's transformation to the modular force and the intended fielding of the Future Combat System (FCS) calls for an even greater number of Army UA to be acquired and employed. They will become organic assets to their Brigade Combat Teams (BCT) and will be operated by members of the BCT. This will increase overall UA numbers even more, which predictably increases the potential for conflicts with other aircraft, both manned and unmanned. Additionally, the SUAVs are generally too small to outfit with traditional identification friend or foe (IFF) equipment to assist in their tracking. Organic BCT UA will be operated down to the company level, which is also a new concept. The intent of company-operated UA is to assist commanders at the lowest

levels in gaining actionable intelligence and enable them to focus their combat power where required.

These changes within the U.S. Army are being mirrored elsewhere. Other U.S. military services, as well as other government agencies, allies, and potential future coalition partners, are undergoing changes which are increasing their UA inventories as well. Multiple users (both military and non-military) recognize the undeniable benefits of UA employment. The problem is that the ever-increasing amount of them will congest airspace and present new challenges for their management.

Joint Publication 3-0, *Joint Operations*, outlines the spectrum of military operations. UA are currently utilized across this spectrum with many of these operations areas using UA from each of the Services (see table 1).

Table 1. Types of Military Operations

TYPES OF MILITARY OPERATIONS	
Major Operations	Support to Insurgency
Homeland Defense	Counterinsurgency Operations
Civil Support	Combating Terrorism
Strikes	Noncombatant Evacuation Operations
Raids	Recovery Operations
Show of Force	Consequence Management
Enforcement of Sanctions	Foreign Humanitarian Assistance
Protection of Shipping	Nation Assistance
Freedom of Navigation	Arms Control and Disarmament
Peace Operations	Routine, Recurring Military Activities

Source: Joint Chiefs of Staff, Joint Publication 3-0, *Joint Operations* (Washington, DC: GPO, 2006), I-12.

In mission areas where they are already present, new capabilities are expanding their roles. In addition, they are finding participation in mission areas where they previously had none. As this UAS evolution continues, every area will be conducted, integrated with, or enabled by the UAS. UA now constitute a significant presence in combat airspace and are certain to saturate the future battlespace. Today, there are 800 in service in Iraq. As of February 2006, the Services had over 3,000 in their inventories (see table 2).[16]

As indicated, most of these UA are the SUAS. These pose a significant problem for two reasons. Due to their small size, they are difficult to track and they historically operate in the same airspace as Army rotary-winged aircraft.

Many more UA platforms will be purchased and acquired over the next decade. The desire for near persistent, on-demand ISR and strike capability at the strategic, operational, and tactical levels of war fuels these acquisition efforts. No one denies the outstanding capabilities that UA provide, but saturation could soon render the current airspace network chaotic. The armed forces have to provide joint solutions for the tremendous number of systems in terms of controlling, deconflicting, and coordinating them with respect to other UA as well as manned aircraft, both military and civil.

UA have become critical elements of military capability. They have key roles in both major combat operations and stability operations as demonstrated today in Iraq and Afghanistan. UA are here to stay, and will continue to be a significant and growing presence in the battlespace.

Table 2. Number and Type of Unmanned Aircraft in Department of Defense's Inventory

Type	System	Service/Command	Total aircraft inventory
Small UAS (weight less than 10 lbs./airspeed less than 100 kts.)	Pointer	Air Force/Special Operations Command	126
	Raven	Army/Air Force/ Special Operations Command	1776
	Dragon Eye	Marine Corps/ Special Operations Command	402
	Force Protection Airborne Surveillance System	Air Force	126
	Swift	Special Operations Command	212
	BATCAM	Air Force	54
Tactical UAS (weight less than 500 lbs./airspeed less than 120 kts.)	Pioneer	Navy and Marine Corps	34
	Shadow 200	Army	140
	Neptune	Special Operations Command	15
	Tern	Special Operations Command	15
	Mako	Special Operations Command	15
	Tigershark	Special Operations Command	6
Theater-level UAS	Predator A	Air Force	70
	I-Gnat	Army	4
	Hunter	Army	32
	Fire Scout	Navy/Army	4
	Predator B	Air Force	6
	Global Hawk	Air Force/Navy	11
Total			**3048**

Source: U.S. Government Accountability Office, GAO-06-610T, *Unmanned Aircraft Systems:Improved Planning and Acquisition Strategies Can Help Address Operational Challenges* (Washington, DC: GPO, 2006), 6.

As the number of users and systems increases, the amount of UA occupying the same battlespace in the future will result in significant airspace congestion. Initial UA success was achieved when fewer of them were being operated; UA saturation was not an issue since few of them were in service. At current and proposed UA acquisition rates,

future UA application will have to address the inherent problems that come with a battlespace inundated with UA operated by a myriad of users.

A great deal has been written about what UA can bring to the fight but, to date, much less has been offered about how to manage the sheer numbers of them that will compete for the same piece of sky. The doctrine and procedures to deal with UA saturation are still a work in progress. This statement provides the foundation for the primary research question of this thesis.

Thesis Intent and Primary Research Question

The increased presence of UA in the battlespace is on pace to overextend the existing airspace management architecture. The UAS provides vital contributions to military operations but, with no correction to the present course, those same UA assets can become hazards to manned aircraft and other UA. This condition could eventually force the reduction of their usage and limit their potential to accomplish their intended missions. In this way, UA could become its own worst enemy.

The primary question this thesis intends to answer is, what doctrine and procedures can be applied to impending UA battlespace saturation to allow for their safe and effective employment. In order to answer this question, secondary and tertiary questions will be included to ensure a comprehensive view of the problem.

Secondary questions include: What is the existing airspace control architecture and how will it need to evolve to handle the saturation? How do UA fit into this architecture? What is the current doctrine that governs airspace control? Is current doctrine satisfactory to handle the UA issue? Do the Services have different points of view on UA operation? What types of UA will be operated and what portion of the

airspace is most affected by their presence? What will be different about employing UA across the spectrum of military operations (major combat operations employment versus stability operations employment)? What types of control will be most effective at deconflicting them?

Tertiary questions include: How can UA interrogation (identification friend or foe (IFF)) or a data link be utilized to provide control and deconfliction of UA assets? Will all UA types have some form of IFF or data link capability? If not, what is the solution for those without it? Where should this positional information be transmitted and at what level should overall control exist? What level of coordination should exist among UA users? Can one UA gather appropriate information for multiple users without a "competition" for the same airspace?

Assumptions

Several key assumptions formulate the context for this research and the focus for the primary research question. Over the next ten years, the rate at which UA are acquired and fielded could exceed the DoD's ability to efficiently manage them in a given scenario using the current airspace and procedural architecture.

Other key assumptions: This thesis is focused on the future (ten to fifteen years from now, (2017 to 2022) and based on the premise that the Army's FCS will be funded and fielded at the levels currently programmed. The FCS construct provides the Army's roadmap for resourcing its BCTs with a variety of UA types and numbers. These proposed UA acquisitions by the Army will constitute the plurality (if not the majority) of UA assets operating in a given theater. In addition, the Army's transformation to a modular force with organic UA assets will require an enhanced role for Army Airspace

Command and Control (A2C2). This enhanced role is illustrated by the fact that, in 2005, the Army for the first time flew more UA hours than the Air Force (see figure 2).[17]

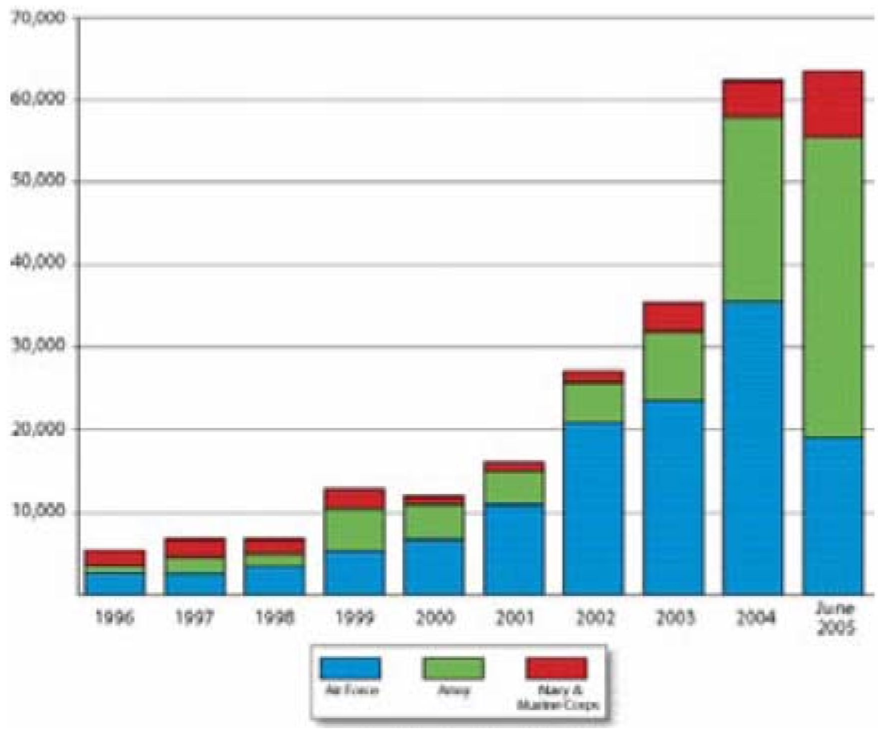

Figure 2. Annual Unmanned Flying Hours, by Service
Source: Adam J. Hebert, "Smashing the UAV Stovepipe," *Air Force Magazine* 89, no. 2 (February 2006): 53.

Of note in figure 2 is that by June 2005, the Services had already exceeded the UA flying hours accomplished in all of 2004. The primary reason why the Army flew more UA hours than the Air Force is the Army's increasing procurement and employment of the SUAS. As indicated in table 2, the SUASs now constitute the majority of the UA and represent the fastest growing UA category.

This research will also assume a future battlespace that will utilize both positive and procedural control. Procedural control, the current method of airspace control for the

majority of Army aviation assets, uses a coordinating altitude (CA) to deconflict airspace activity between users and or aircraft types. Positive control, on the other hand, uses networking technology (IFF, data links, and others) to provide real time control and coordination of airborne entities via voice communications, and positional and friend or foe information. This information alleviates or eliminates the need for procedural control and enables more flexibility. The use of positive control will also assume that joint UA will be able to operate on the same or compatible information networks.

Joint Definition of the Unmanned Aircraft System

Several definitions are available for UA. This thesis will use the doctrinal UA definition from Joint Publication 1-02, "A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Ballistic or semi-ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles."[18] Lighter-than-air platforms, such as balloons and blimps, will be excluded from this research as they do not constitute part of the current or future problem of UA saturation.

Limitations

This thesis is unclassified in its entirety. The research questions posed do not require the inclusion of classified sources. Open source data is available to answer the questions and will allow this research to be more easily accessible and distributed through more channels.

In addition, to keep this topic focused, the research will primarily be conducted from an Army-Air Force perspective. Over the next ten to fifteen years, the Army and Air Force will field and employ the vast majority of military UA and will therefore be the focus of the research. Another assumption of this thesis is that Navy and Marine Corps UA assets can operate within the framework provided by Army-Air Force derived solutions. Combined (allied and multinational) UA issues will not be addressed; Army-Air Force doctrinal and procedural solutions will be the focus in order to keep the research specific. As with the Navy and Marine Corps, Army-Air Force solutions will likely have follow-on applicability for combined UA deconfliction issues involving allies and or coalition partners.

As there is a great deal of emphasis on U.S. Army UA, this research will be limited to the current concept of the Army FCS. The FCS concept continues to evolve and might vary slightly over the next several years from its current model. This research will use the 2006 FCS concept that calls for 212 UA in every Army brigade.[19]

Except to help provide a context for the research recommendations, this thesis will not address the specific air defense implications of an enemy using their own UA to infiltrate friendly airspace and conduct operations against friendly forces. Suffice it to say that this is both a possibility and further impetus for the joint force to establish comprehensive airspace control doctrine to avoid a variety of negative impacts that include this risk.

Another ramification of UA management that will not be addressed is the issue of bandwidth management. UA operate remotely via electronic signals and a given area or operating system can only accommodate so many of these signals. Electromagnetic

washout and interference can adversely affect a given UA's control signal and, as a result, its ability to maintain controlled flight and transmit data. For this reason, managing the flight control and linking capacity of the battlespace is yet another issue for the joint force to resolve, but one that will not be focused on in this thesis.

Chapter 2 will examine existing applicable doctrinal and procedural literature from Joint, Army, and Air Force sources, as well as look at how this doctrine is being executed in OIF.

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[1]White House, President Bush Speaks on War Effort to Citadel Cadets, 11 December 2001, Office of the Press Secretary, The White House; available from http://www.whitehouse.gov/news/releases/2001/12/20011211-6.html; Internet; accessed on 15 October 2006.

[2]Rebecca Rayko, "Airspace Congestion Over the Battlefield Affects UAVs," Defense News Media Group--Joint Warfare Conference, 26 October 2005; available from http://www.defensenews.com/promos/conferences/jw/1198784.html; Internet; accessed on 31 December 2006.

[3]Office of the Secretary of Defense, *Roadmap 2005-2030*, 1-2.

[4]Ibid., 2.

[5]Ibid.

[6]Remote Piloted Aerial Vehicles: An Anthology, Monash University; available from http://www.ctie.monash.edu/hargrave/rpav_home.html#Beginnings; Internet; accessed on 8 September 2006.

[7]Ibid.

[8]Ibid.

[9]Jane's Information Group, ed. *Jane's Unmanned Aerial Vehicles and Targets* (London: Jane's Defense Publications, Intl., 1999), 24.

[10]William Wagner, *Lightning Bugs and Other Reconnaissance Drones* (Fallbrook, CA: Aero Publishers, 1982), 1.

[11]Ibid., 23.

[12]Department of Defense, *UAV Annual Report, FY 1996* (Washington, DC: Defense Airborne Reconnaissance Office, 1996), 14.

[13]Ibid.

[14]Jane's Information Group, 45.

[15]U.S. Government Accountability Office, GAO-06-610T, *Unmanned Aircraft Systems: Improved Planning and Acquisition Strategies Can Help Address Operational Challenges* (Washington, DC: GPO, 2006), 6.

[16]Ibid., 7.

[17]Adam J. Hebert, "Smashing the UAV Stovepipe," *Air Force Magazine* 89, no. 2 (February 2006): 51.

[18]Chairman, Joint Chiefs of Staff, Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: GPO, 2005), 563.

[19]Colonel David M. Neuenswander, Leader, OIF-OEF Airspace Command and Control Collection and Analysis Team, Interview by author, 12 February 2007.

CHAPTER 2

LITERATURE REVIEW

Overview

> It's the effects that count, not where the platforms fly, reside, or orbit.[1]
>
> John T. Correll, Editor in Chief

While this is true, the reality is that those desired effects will require many airborne assets, especially at low altitude. Many UA, by necessity, fly at these low altitudes and, in this sense, "where the platforms fly" is a significant aspect of the airspace saturation problem. Chapter 1 illustrated the issue of UA congesting future military airspace. As UA continue to grow in number, capability, and mission type, military UA operators will require more time and more airspace to accomplish their specific missions. This will cause the demand for already limited airspace to increase. The requirement for multiple UA presents challenges for all UA users and those in manned aircraft, as well as for the leadership and personnel charged with ensuring the airspace is managed safely and effectively. The purpose of this research is to determine what procedures and doctrine can be applied to effectively control, deconflict, and coordinate the multitude of UA which will occupy the future battlespace.

The current literature and publications on UA in general are numerous, reflecting the fact that UA are on the cutting edge of battlefield technology. Much has been written about the UAS and its emergence as a multifunctional weapons system, but comparatively little has been written on how to manage these assets operating in a UA-saturated environment. As a result, the literature in this field lacks clear solutions to this

issue. A great deal of expertise continues to be accumulated in the UA field regarding their employment, but attention must also be focused on their management.

The value of the UAS as a battlefield asset continues to increase, and it has become an indispensable weapon in modern military arsenals. UA are undoubtedly valuable platforms; their value is the driving force behind the current UA acquisition explosion. Most written sources continue to focus on UA emerging capabilities and future application. These sources tend to ignore how the systems interact with other airborne assets and how they fit into the existing airspace architecture. This literature review will focus specifically on DoD, Joint, Air Force, and Army doctrine and publications in order to determine potential solutions that consider the perspective and capabilities of each to determine the way ahead. The intent of this research is to understand current doctrine and procedures as they provide the framework and context for the UA saturation issue.

The Department of Defense Unmanned Aircraft Vision

The Defense Department has developed a specific UA vision for the future. *The Department of Defense UAS Roadmap 2005-2030* is a plan developed by the Office of the Secretary of Defense which comprehensively charts the course for all Service UA. It is intended to be all-encompassing, and addresses issues ranging from system development and procurement to manning and interoperability. The document does not, however, get into the specifics of airspace concerns for UA users in a military area of operations (AO). It examines the UA as a military system, but not necessarily as a system with the overall airspace system. Although airspace management is not specifically covered, the *UAS Roadmap* is nonetheless a key document as it sets the stage for the

direction of DoD's UAS programs. Perhaps the most significant piece of information to be taken from the document is that the DoD plans to replace numerous manned aircraft missions with UA over the coming decades. This should give the DoD a parallel incentive to solve military airspace congestion issues before the UA boom overwhelms the architecture within which they will operate.

The document identifies that thousands of Army and Air Force UA will be procured over the next ten to fifteen years. This massive figure illustrates the growing number of small UA, many of which are organic to Army units, which will operate in the increasingly burdened low altitude structure. These UA are flown at low altitudes (below 3, 000 feet above ground level (AGL), which means they do not require Air Tasking Order (ATO) inclusion or prior coordination with controlling entities. This low altitude environment has become the primary domain for these small flying machines.

Identifying the Spectrum of Unmanned Aircraft

UA can be integrated with multiple users for an assortment of tasks throughout the battlespace. They have become an increasingly helpful tool to locate and engage hostiles in the contemporary operating environment. UA possess a wide variance in capability, endurance, operating envelopes, and size. To help identify this spectrum of UA, some examples are included below. They are just a snapshot of existing and emerging UA, but should provide an illustration of the spectrum of systems that will occupy a piece of the future battlespace. The spectrum can be described by its diverse characteristics with some UA weighing as little as a few pounds and others weighing nearly 33,000 pounds, the smaller of which can be hand-launched while the larger require conventional runways.

The micro air vehicle shown in figure 3 is an example of one of the systems (Class I UA) from the Army's FCS concept. This type of UA will operate in conjunction with platoon-sized units. It weighs 15 pounds and is just 15 inches long.[2]

Figure 3. Micro Air Vehicle Concept
Source: Office of the Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030* (Washington, DC: GPO, 2005), 29.

The Raven (shown in figure 4) weighs just 4 pounds and is slightly longer than 3 feet. Over 300 Ravens will ultimately be procured by the Army alone. It, like the Micro Air Vehicle, is employed by small ground units, operates at low altitudes (around 500 feet AGL) for periods of approximately thirty minutes at ranges seldom farther than a few miles from its controller.[3]

Figure 4. Hand-launch of an Army Raven
Source: Office of the Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030* (Washington, DC: GPO, 2005), E-16.

The RQ-7 Shadow, shown in figure 5, is an example of the tactical UAV which is organic to an Army maneuver BCT. The Army plans to procure more than 250 Shadows. Each weighs 375 pounds and is over 11 feet long.[4]

Figure 5. Army RQ-7 Shadow
Source: Adam J. Hebert, "Smashing the UAV Stovepipe," *Air Force Magazine* 89, no. 2 (February 2006), 54.

The Air Force Predator, shown in figure 6, has been the workhorse of UA since the late 1990s. It carries the MQ designation (rather than RQ) because it is multi-role,

accomplishing both ISR and strike. More than 160 will eventually be acquired by the Air Force. It is 27 feet long and weighs nearly 2300 pounds.[5]

Figure 6. Air Force MQ-1 Predator
Source: Office of the Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030* (Washington, DC: GPO, 2005), “Appendices” title page.

The Global Hawk, shown in figure 7, is currently the largest UA in the military inventory. It is 47 feet long and weighs nearly 33,000 pounds. It can remain airborne for 24 hours and is intended to replace the Air Force U-2 as a strategic ISR platform. The Air Force plans to acquire a total of 58 RQ-4s.[6]

Figure 7. Air Force RQ-4 Global Hawk
Source: Office of the Secretary of Defense. *Unmanned Aircraft Systems Roadmap 2005-2030* (Washington, DC: GPO, 2005), A-9.

Unmanned Aircraft for the Army's Modular Division

Understanding what this UA proliferation actually looks like is fundamental to conceptualizing the airspace saturation problem. The organic UA assets of a notional modular division with FCS are indicated in figure 8.

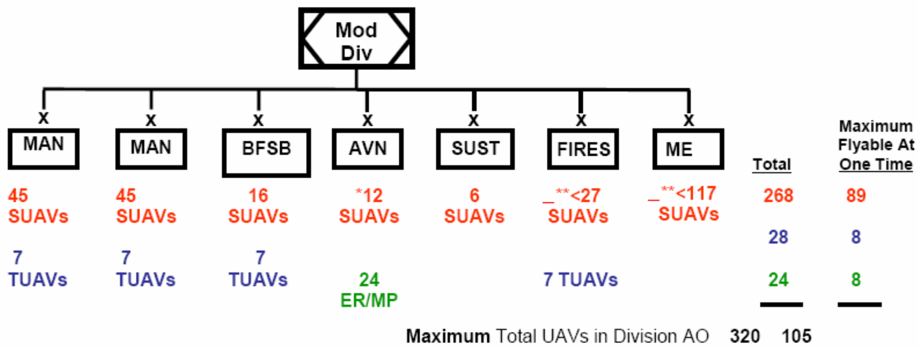


Figure 8. Example Modular Division
Source: TRADOC Program Integration Office, Battle Command, A2C2 Cell, "Army Airspace Command and Control in the Modular Force," Fort Leavenworth, KS: GPO, 29 April 2005.

The integration of new assets like these and the solution to the UA management issue is ultimately an airspace management issue. The UA is simply the physical entity which is now, and will continue to be, the new and increasingly more numerous resident of joint airspace. The solution lies in determining how UA most safely and effectively fit into the airspace architecture and how that architecture must adapt (via doctrine and procedures) to enable lasting solutions.

Coordinating Altitude: The Problem Lies Beneath

The airspace saturation issue can best be illustrated by a depiction of the CA. The CA is a designated altitude that nominally divides fixed-wing and rotary-winged aircraft.

In a very generic (and not entirely correct) way, the CA is often referred to as the proverbial "brick wall" between Air Force and Army aircraft, with the Air Force fixed wing aircraft above the CA and the Army rotary-winged aircraft below. The CA concept is illustrated in figure 9.

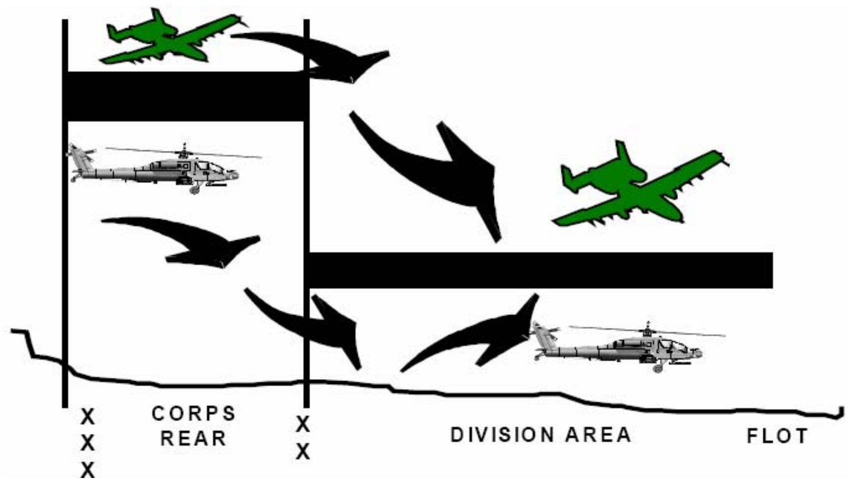


Figure 9. Depiction of the Coordinating Altitude
Source: Department of the Army, Field Manual 3-52, *Army Airspace Command and Control in a Combat Zone* (Washington, DC: GPO 2002), 4-3.

The majority of new UA operated by the Army are the small Class I and II. They are primarily employed below the CA along with other organic Army UA and helicopters. A description of these UA and the standard operating airspace is illustrated in table 3.

Table 3. Future Combat Systems Unmanned Aerial Vehicles

FUTURE COMBAT SYSTEMS UAVS : 2020 AND BEYOND			
System Echelon	**Operational Radius**	**On-Station Time**	**Operational Altitude AGL (MSL*)**
UAV Class I *Support Platoons*	8 km (T) 16 km (O)	50 min (T) 90 min (O) per vehicle	500 ft AGL (10,500 MSL)
UAV Class II *Support Companies*	16 km (T) 30 km (O)	2 hours (T) 5 hours (O)	1,000 ft AGL (11,000 ft MSL)
UAV Class III *Support Battalions*	40 km (O)	6 hours (T) 10 hours (0)	2,000 ft AGL (12,000 ft MSL)
UAV Class IV*** *Support Brigades* ****More than one type vehicle may be used to accomplish the mission sets for this action*	75 km (T) 400 km (O)** **Limited duration in support of operations moves	18-24 hours (O)	6,500 ft AGL (min) (16,000 ft MSL)

Source: Department of the Army, *Army Transformation Roadmap 2003* (Washington, DC: GPO, 2003), 8-10.

As indicated in table 3, Class I and II normally operate at or below 1,000 feet AGL and seldom fly farther than 20 km from their units. Command and control (C2) elements normally have no visibility of Class I and II UA on the ATO or in real time. The ATO provides detailed daily information on joint aviation assets, but is not all inclusive as in the case of very small UA. The major area of airspace concern is this low altitude band below the CA where many assets operate with minimal visibility.

The Army's FM 3-52, *Army Airspace Command and Control in a Combat Zone,* summarizes this reality and discusses the responsibility for operating them.

> UAVs provide a significant challenge due to their small size, agility, and increasing density as well as their limited ability to detect, see, and avoid other aircraft. UAVs pose an operational hazard to manned aircraft operating nearby. UAV flights, like manned aircraft flights, must be coordinated to ensure deconfliction with other airspace users.[7]

Joint Doctrine

Joint Doctrine Fundamentals

The primacy of joint doctrine is fundamental to this research and to the solution of this problem. Joint doctrine takes precedence over Service doctrine and determines the course of action when Service doctrines conflict. Joint doctrine also contains several keystone publications which provide the Services with critical guidance and fundamental concepts that dictate the manner in which all joint operations should be conducted.

Joint Publication 3-0, *Joint Operations,* is one of these keystone publications. Its guidance includes the principles of war. These nine principles provide the foundation for the principles of joint operations (see figure 10).

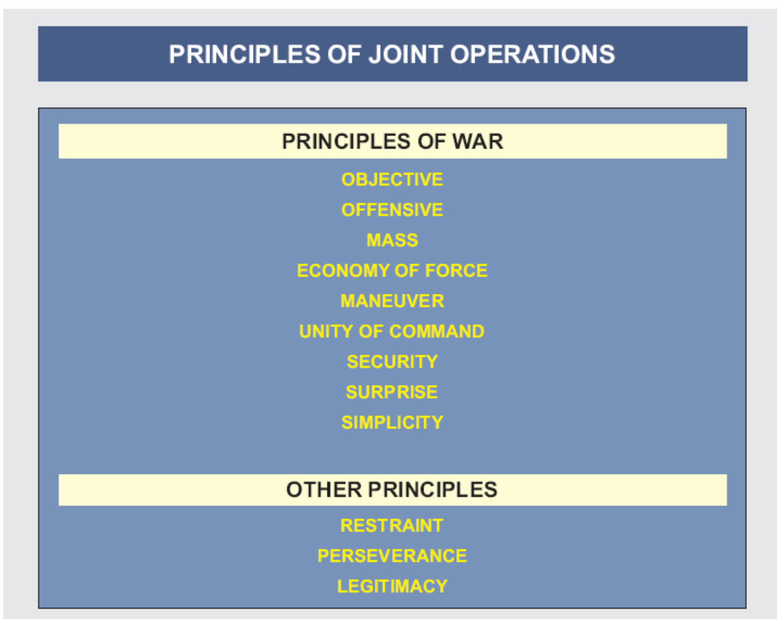


Figure 10. Principles of Joint Operations
Source: Chairman, Joint Chief of Staff, Joint Publication 3-0, *Joint Operations* (Washington, DC: GPO, 2006), II-2.

Experience throughout the history of joint operations demonstrates that unity of command is vital for those operations to be successful. Interestingly, in the case of UA, unity of command is not realistic. It would be infeasible to subordinate all UA to a single commander. Air Force UA operate to serve various customers, who generally change from mission to mission or from day to day. Organic Army UA operate to serve the unit that employs it. This division of labor is ultimately a necessity and, since true unity of command is not likely for all UA assets, unity of effort must exist.

The other principles of war that bear most on this issue are objective, economy of force, and simplicity. The objective in any military operation must be clear, as should the need for employing specific assets to accomplish it. One of the characteristics of a UA-heavy environment is multiple targets for UA servicing. Users must be disciplined to ensure their UA employment and airspace usage satisfies the objective.

Economy of force refers to the correct and timely application of military assets to ensure their efficient use where a given capability is truly required. Although growing in number, the demand for UA in most cases will likely exceed the supply. They must be operated in an efficient and economical manner to ensure their availability to service the units and situations that truly require them.

Simplicity, the final principle of war to be addressed, requires that the UA saturation solution not be a complex one. It must be easily understandable and one that can fit into the existing airspace architecture by modifying doctrine and procedures, not by completely overhauling the existing airspace C2 structure and turning it into something unrecognizable and, therefore, confusing.

Joint Publication 1, as a foundational doctrine document, establishes the Joint Warfare Fundamentals (see figure 11). All of these fundamentals bear on the UA deconfliction issue, but unity of effort is perhaps the most significant. In the absence of unity of command (as previously described), it is an absolute necessity.

Figure 11. Joint Warfare Fundamentals
Source: Chairman, Joint Chief of Staff, Joint Publication 1, *Joint Warfare of the Armed Forces of the United States* (Washington, DC: GPO, 2000), III-8.

Unity of effort demands that joint warfighters work together in the application of their resources to accomplish their individual missions. These must ultimately contribute to the accomplishment of the overall mission and the Joint Force Commander's (JFC) intent. The JFC's intent defines the effort and, because no single entity commands and controls all UA, each airspace control entity and UA operator must function with other

users in mind and with the understanding that their individual actions have effects which can adversely influence that overall, big picture mission.

In the case of airspace requirements for unmanned aircraft, UA users have to recognize that a given section of airspace can only facilitate a fixed number of airborne assets at a time and that some UA missions may have to be postponed or cancelled if other users (manned or unmanned) have higher priority. In this case, UA task coordination may be the only alternative when deconfliction requirements mandate a restriction on the number of UA that can be airborne. The concept of one platform collecting intelligence or striking a target for more than one user must be an option for the joint force in the face of increasing airspace demands.

Concentration is vital as well. UA users, especially at the tactical level, need to recognize that an omni-present UA (even if it is organic) is not necessarily the best answer. Flying UA to collect on or strike a specific target, at a specific time will ease future airspace burdens. The ability to launch a UA does not automatically translate to the necessity to do so. UA capabilities need to be concentrated on the specific points in the battlespace where they can enhance the combat effectiveness of the joint warfighter.

Joint Doctrine for Airspace Control

Joint doctrine is most plentiful and specific on this subject in Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*. The purpose of airspace control is to enable joint operations in order to accomplish the JFC’s objectives (see figure 12).

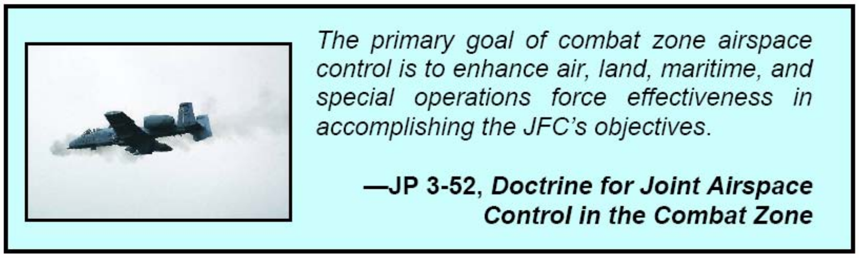


Figure 12. Goal of Combat Zone Airspace Control
Source: Chairman, Joint Chief of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), I-2.

JP 3-52 provides the basis upon which the UA deconfliction issue will be remedied. The guidance contained in JP 3-52 provides the framework within which joint and Service doctrine and procedures are developed. In addition, the primacy of joint doctrine will mandate that Service doctrine supports it. This document views UA the same as manned aircraft with respect to their planning, employment, and airspace control procedures. This concept is significant because it mandates that each UA be controlled via methods consistent with other aircraft, which reflects the fact that each of them, regardless of size, is a potential battlespace hazard requiring planning and control measures to mitigate the potential risk associated with their operation.

Methods of Airspace Control

Army FM 3-52 establishes the A2C2 elements at various levels as the organization that provides the Army with airspace C2. Its various elements provide the structure for airspace C2, but A2C2 does not normally have the organic assets required to allow the Army to control the airspace over its areas of operations (AOs). This lack of airspace control capability has led to a reliance on procedural control by the Army to deconflict air operations. As identified in table 4, procedural control methods are required

when real time C2 capability is limited. As indicated, an architecture of radar systems or data links, for example, is needed to provide positive control.

Table 4. Methods of Airspace Control

METHODS OF AIRSPACE CONTROL	
Positive Control	**Procedural Control**
Positively identifies, tracks, and directs air assets using: • Radars • Other sensors • Identification, friend or foe/ Selective identification feature • Digital data links • Other elements of the command, control, communications, and computer system	Relies on previously agreed to and promulgated airspace coordinating measures such as: • Comprehensive air defense identification procedures and rules of engagement • Low level transit routes • Minimum risk routes • Aircraft identification maneuvers • Fire support coordinating measures • Coordinating altitudes

Source: Chairman, Joint Chief of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), III-4.

JP 3-52 establishes the methods of airspace control. Three general categories of airspace control are: positive, procedural, or a combination of the two. These will vary depending on the type of military operation and its requirements. JP 3-52 further describes that the Joint Force Air Component Commander (JFACC), through the Airspace Control Plan (ACP), must apply the appropriate control based on joint force capabilities and limitations.

Procedural control limits the amount of flexibility of the joint force, but is necessary when real time communication with airborne assets is limited or non-existent.

According to FM 3-52, Army A2C2 cells integrate airspace use in accordance with the ACP below the CA. These cells do not control this airspace; they manage it by developing and distributing procedural control measures. With current capability, A2C2 cells generally rely on procedural control, with very little positive control, to manage airspace below the CA. As depicted in the figure 13, A2C2 has a variety of procedural control measures at its disposal.

Procedural Airspace Control Measures

- Air Defense Identification Zones (ADIZ)
- Coordinating Altitude (CA)
- High-Density Airspace Control Zone (HIDACZ)
- Low Level Transit Routes (LLTR)
- Minimum Risk Routes (MRR)
- Restricted Operations Area and Restricted Operations Zones (ROA/ROZ)
- Return-to-Force (RTF) Profile*
- Special Operations Forces Operating Areas
- Special Use Airspace
- Standard Use Army Aircraft Flight Routes (SAAFR)
- Weapons Engagement Zones (WEZ)
    - Base Defense Zone (BDZ)
    - Fighter Engagement Zone (FEZ)
    - Joint Engagement Zone (JEZ)
    - Missile Engagement Zone (MEZ)

* NOTE: The RTF profile may create errors in the Contingency Theater Automated Planning System (CTAPS)/Theater Battle Management Core System (TBMCS).

Figure 13. Procedural Airspace Control Measures
Source: Department of the Army, Field Manual 3-100.2, *Multi-service Procedures for Integrated Combat Airspace Command and Control* (Langley AFB, VA, Air Land Sea Application Center, June 2000), II-4.

These methods are shown in the following graphic depictions. The most significant information to glean from these illustrations is that the procedural control measures are physical entities in and of themselves that use varying sizes of airspace to

be implemented. Figure 14 depicts the relationship between the CA, a Restricted Operating Area, a Restricted Operating Zone, and a High Altitude Missile Engagement Zone (HIMEZ).

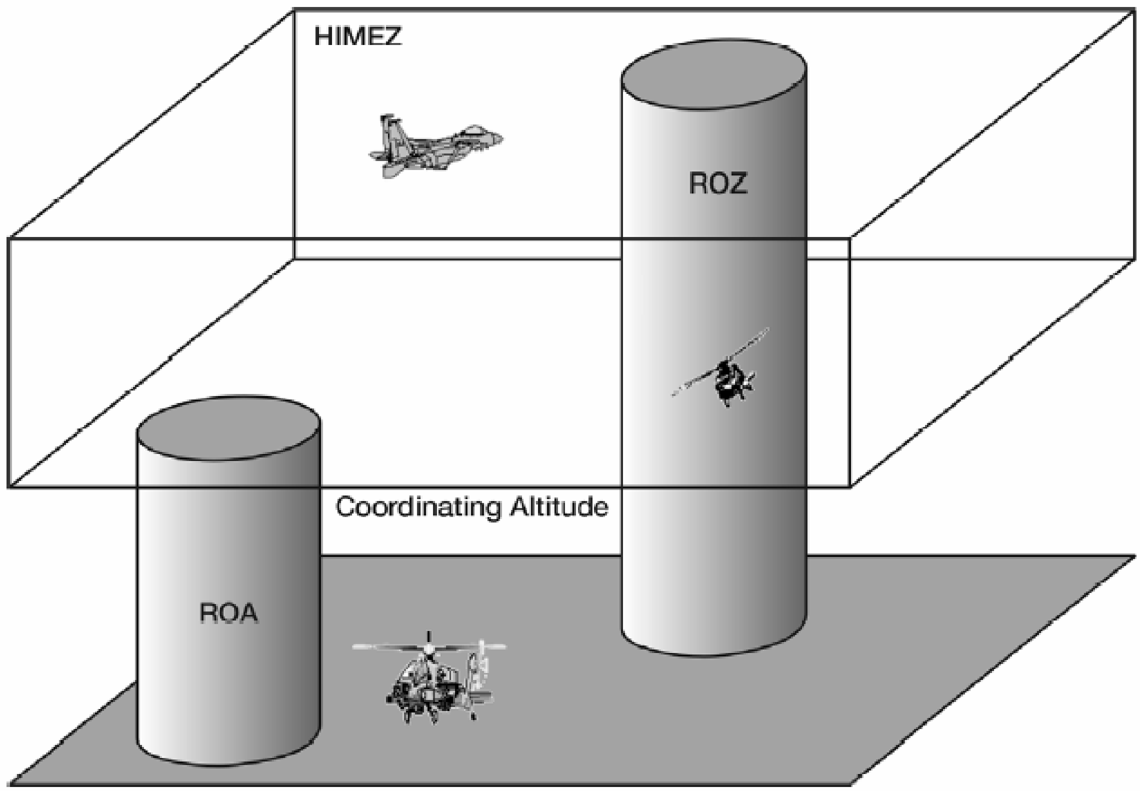


Figure 14. Coordinating Altitude, High Altitude Missile Engagement Zone, Restricted Operating Area, and Restricted Operating Zone
Source: Department of the Air Force, Air Force Doctrine Document 2-1.7, *Airspace Control in the Combat Zone* (Washington, DC: GPO, 2005), 64.

The Restricted Operating Area is a piece of protected airspace below the CA, while the Restricted Operating Zone depicted extends from the surface through the CA and to the ceiling of the HIMEZ. As depicted below, Restricted Operating Area can be

used for a variety of airspace activities, including UA employment and airborne troop delivery.

Comprehensive positive control requires a wide-ranging network complete with a real time common operating picture (CPO) and persistent voice communications. The other extreme, with none of these capabilities, is total procedural control. Because the airspace architecture lies somewhere in the middle of these two methods of control, and relies on elements of both, a mix of the two is currently employed.

Airspace Control Authority--The Joint Force Air Component Commander

JP 3-52 provides the guidance for combat airspace control through various products issued under the authority of the JFC. The ultimate goal of this process is the enhancement of the joint force's combat effectiveness and success. The JFC owns the process because, ultimately, the airspace control system must support his or her objectives. While various Service control systems may have primacy in certain blocks of airspace, all airspace ultimately belongs to the JFC and is managed by the Airspace Control Authority (ACA). The JFC normally appoints the JFACC to assume duties as both the ACA and Area Air Defense Commander to administer the airspace control process.[8] The JFACC, therefore, is responsible for airspace control in the combat zone. To establish this control, the JFACC is doctrinally bound by the fundamentals shown in table 5.

Table 5. Basic Principles of Airspace Control in the Combat Zone

BASIC PRINCIPLES OF AIRSPACE CONTROL IN THE COMBAT ZONE
• Unity of effort
• Reduce the risk of friendly fire and optimize the effectiveness of air defense
• Maintain close liaison and coordination among all airspace users
• Require common combat zone airspace control procedures
• Require uncomplicated procedural control measures
• Require reliable, jam-resistant and secure communications networks
• Require survivable and redundant airspace control systems
• Respond to developing enemy threat conditions and to the unfolding operation
• Airspace control functions rely on airspace management resources but these functions are different than the air traffic control environment
• Emphasize flexibility and simplicity
• Support 24 hour operations in all-weather and environmental conditions

Source: Chairman, Joint Chief of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), I-4.

Unity of effort is once again addressed in this publication primarily because, even though the JFACC (as the ACA) is responsible for airspace control, unity of effort cannot be established without the combined effort of the many players who utilize the airspace to accomplish the JFC’s objectives. This key principle points out that airspace control requires the participation and coordination of all airspace users toward a common objective. Unity of effort is enabled by close liaison and coordination among all airspace users. In order for users to coordinate, airspace control requires common control procedures, uncomplicated procedural control measures, reliable communications networks (jam-resistant and secure), and survivable and redundant airspace control systems. The other basic principles of airspace control, flexibility and simplicity, have

roots in the fundamental joint doctrine principles previously described. Combat requires both.

The ACA, normally the JFACC, develops an ACP. According to Joint Publication 1-02, the ACA is the commander with overall responsibility for the operation of the airspace control system in the airspace control area.[9] Described below are the key considerations of the ACP that bear on the UA saturation issue.

Limitations or adverse conditions within air, land, and maritime situations in the operational area, such as existing equipment limitations, electronic warfare, and command, control, communications, and computer requirements may adversely affect the ACP and will undoubtedly vary from theater to theater and depend on how long the joint force has been in a particular theater.[10] Joint forces' combat zone airspace control measures may initially be complicated in the early period of theater presence by an initial lack of airspace infrastructure.

The ACP also has to account for various UA flight profiles. These vary based on UA type and mission. This is especially true when surge operations, which require high volumes of air traffic, are necessary. UA flight profiles need to be incorporated into the larger air control picture because of potential restricted areas based on initial deployment of friendly air mobility assets and subsequent air mobility integration with combat forces, logistic resupply, aerial refueling, or aeromedical evacuation.[11]

The ACA is ultimately responsible for this airspace control. The ACA coordinates and integrates the use of the airspace, and develops the policies and procedures of airspace control. To meet the needs of the JFC, the ACA also determines the coordination required among units within the operational area. Joint doctrine allows

the ACA flexibility with respect to procedures because the airspace control system must be responsive to the JFC.[12]

The system must also provide for integration of the airspace control system of the host nation, provide a civil structure where none exists, and coordinate and deconflict user requirements. This ACP, once approved by the JFC, is implemented through the Airspace Control Order (ACO). In order to execute the ACP, the ACA must provide the necessary facilities and personnel for airspace control functions in assigned areas and identify these facilities and personnel for inclusion in the ACP.[13]

The principles for planning airspace control in the combat zone are: interoperability, mass and timing, unity of effort, integrated planning cycles, and degraded operations (see table 6).

Table 6. Principles for Planning Airspace Control in the Combat Zone.

Source: Chairman, Joint Chief of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), III-2.

All of these principles have implications for joint cooperation. Joint airspace planning requires cooperation. The intended result of this cooperation and planning is to satisfy the principles which allow the ACP to be successful.

The objectives for airspace control procedures are to prevent mutual interference, facilitate air defense identification, safely accommodate and expedite the flow of all air traffic in the operational area, enhance effectiveness in accomplishing the JFC's objectives, and prevent friendly fire incidents.[14] These objectives illustrate the broad spectrum of airspace control responsibilities, and UA operations impact each of these objective areas in one way or another.

The JFACC, as ACA, can delegate airspace control to a component in the ACP or ACO. Specifically, this delegation occurs by using an Airspace Control Sector in large areas or a High-Density Airspace Control Zone in small areas.[15] The ACO is the instrument the JFACC uses to deconflict, coordinate, and integrate combat airspace. The JFACC's role as the ACA includes the following obligations as laid out in JP 3-52 (see table 7).

Many current attempts to carry out these responsibilities with respect to UA are seen as ad hoc efforts and not necessarily lasting solutions. JP 3-52 demonstrates that the broader, doctrinal guidelines are, in many cases, pertinent and sufficient. It is the application of this doctrine which is the real issue and requires new processes to manage the increasing number of aircraft (primarily UA) in combat airspace.

Table 7. Airspace Control Authority Responsibilities

AIRSPACE CONTROL AUTHORITY RESPONSIBILITIES

- Coordinate and integrate the use of the airspace.
- Develop policies and procedures of airspace control and for the coordination required among units within the operational area.
- Establish an airspace control system that is responsive to the needs of the joint force commander, provide for integration of the airspace control system with that of the host nation, assist in establishing a civil structure where none exists, and coordinate and deconflict user requirements.
- Develop the airspace control plan and, after joint force commander approval, distribute it throughout the operational area. Implement the airspace control plan through the airspace control order.
- Provide necessary facilities and personnel for airspace control functions in assigned areas and identify these facilities and personnel for inclusion in the airspace control plan.

Source: Chairman, Joint Chief of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), II-3.

JP 3-52 also lays out the fundamental considerations of airspace control in the combat zone. These are the conditions in which joint air assets operate and the context in which the ACA must provide airspace control consistent with the JFC's intent. There are a total of fourteen considerations, and several have significant implications for this research.

JP 3-52's first fundamental consideration of airspace control in the combat zone is the need for each Service or functional component within the joint force to operate a variety of air vehicles and weapons systems, both high and low speed, rotary- and fixed-wing (manned and unmanned), within the combat zone airspace control area.[16] Joint doctrine recognizes that multiple users operating a variety of aircraft is an assumption of combat airspace.

The next consideration for combat zone airspace control is the need for each Service and functional component to have maximum freedom to use the airspace consistent with the degree of operational and tactical risk acceptable to the JFC.[17] This recognizes that proper airspace usage is vital to mission accomplishment, and that conditions of risk should not be a self-inflicted characteristic of friendly airspace congestion.

Another key consideration is the need for the combat zone airspace control system to be responsive to the requirements of the joint force.[18] The airspace control system needs to be capable of supporting high-density traffic and surge operations as required by the JFC. This aspect of doctrine accepts the premise that operations may require high-density air traffic; operations are driven by mission requirements and should not be limited simply because the airspace architecture is insufficient to handle it.

Tied closely to this consideration is the need for close coordination and integration of surface force operations, fires, air operations, air defense operations, special operations, and airspace control activities.[19] As indicated, there are a myriad of functions that are conducted through, and by air. UA employment is just one part of this larger scheme, but represents the most rapidly growing entity that must be incorporated into all the other elements. Airspace management is extremely dynamic and must account for all functions that require airspace use.

Non-JFACC Airspace Control Authority

As discussed, JP 3-52 also establishes ACA. At the direction of the JFC or from ACP procedures, a portion of airspace may be assigned to a commander to accomplish a specified mission or to facilitate decentralized execution. When this occurs, that

commander becomes the control authority for the airspace assigned to him. Under this arrangement, his responsibilities include unity of effort, minimum interference along AO boundaries, and coordination for aircraft entering and departing this airspace.[20] The reality of congestion below the CA will drive the JFACC to assign Army commanders (division level) portions of airspace within their AO. This sector control requires that the Army commander has the assets to provide control. This requirement will increase the responsibility of A2C2 elements and highlight the need for the organic assets and trained personnel to fulfill this expanded role.

Control and Reporting Centers (CRC) do not normally accept responsibility for the control and deconfliction of airspace in an area smaller than 10 by 10 nautical miles. Because Army airspace users often require multiple UA in an area this small, the ACA allows A2C2 cells to manage airspace within a division AO below the CA. In this circumstance, the A2C2 cell only has authority over its division aviation assets, but not over all users inside its assigned airspace.[21]

Tools of the Airspace Control Authority

The need for the airspace architecture to be able to accommodate mission requirements should not be confused with unlimited airspace access by all users, or with the concept of a "breaking point" of what a given airspace can handle. Joint doctrine recognizes the need to identify saturation levels and limitations of airspace control networks. To manage saturation of these networks, the ACA has a myriad of processes available. Joint doctrine calls for temporary restrictive airspace coordinating measures (ACM) for certain areas of airspace to allow subordinate commanders maximum freedom of action. For example, the inclusion of some airspace above a subordinate commander's

AO may be necessary to allow that commander the maneuver space he or she requires to execute his or her tactical plans.

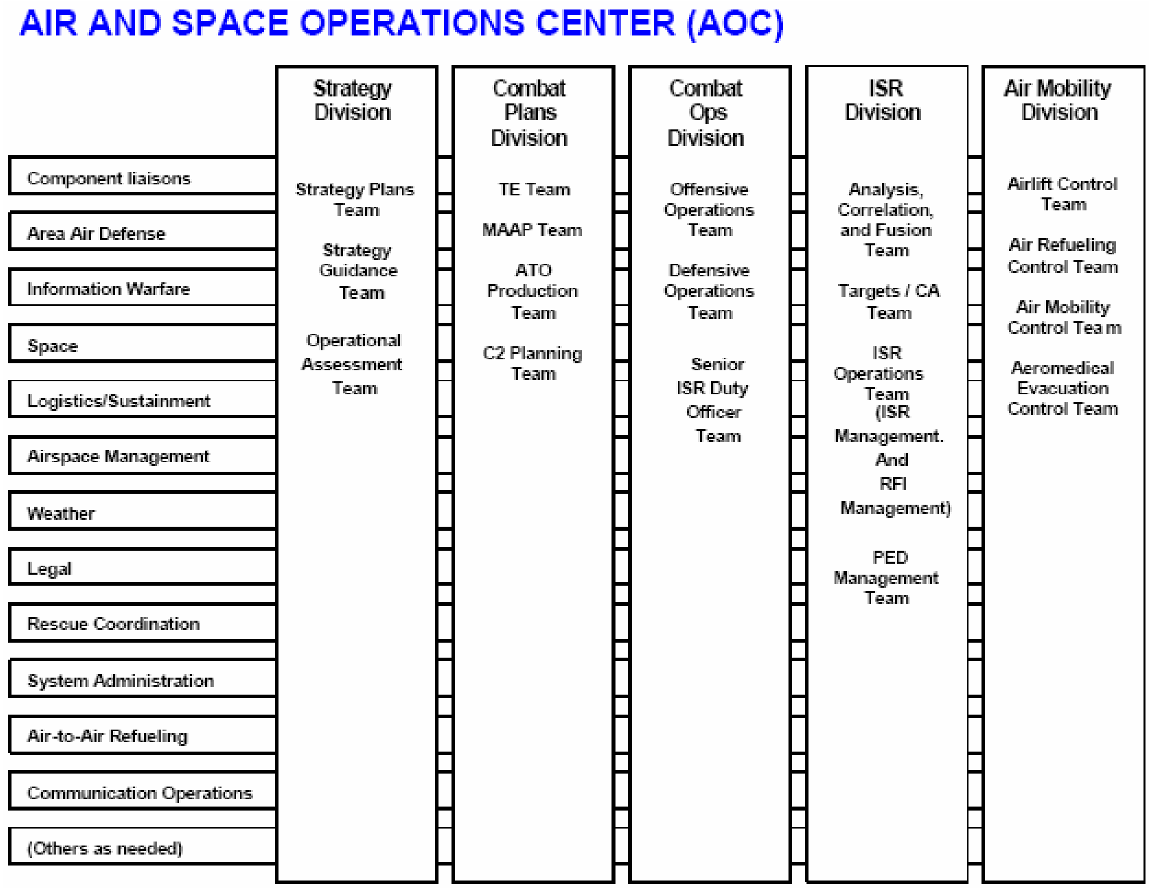
FM 3-52 summarizes the methods by which the ACA can manage UA operations.

> The ACA may establish specific UAV flight routes and altitudes and publish them in the airspace control plan. The established principles of airspace management used in manned flight operations normally apply to UAV operations, but may be waived by the JFC. UAV missions may be both preplanned and immediate in nature. Preplanned UAV flights should be included in the air tasking order, special instructions, or ACO. Immediate UAV missions will be coordinated with the appropriate airspace control agencies to safely separate UAVs from manned aircraft and to prevent inadvertent engagement by friendly air defense elements.[22]

The JFC issues an ACP and an ACO through the JFACC. The ACP and ACO express how the airspace usage will support joint force mission accomplishment.[23] The JFACC utilizes a number of entities to administer these airspace tools and manage the airspace. The Joint Air and Space Operations Center (JAOC), CRC, Air Traffic Control (ATC) elements, and the Air Support Operations Center (ASOC) are used to control airspace in accordance with the JFC’s ACP.[24]

The Air and Space Operations Center is the JFACC’s (and therefore the ACA’s) primary C2 tool. It is comprised of multiple directorates that have functional areas woven into them (see table 8). The Air and Space Operations Center is a joint operation and relies on its various liaison personnel in order to transmit and process the vast amount of information required to conduct joint air operations. The Army element in the Air and Space Operations Center is the Battlefield Coordination Detachment (BCD). The BCD is the ACA’s link to the A2C2 elements.

Table 8. Basic Structure of a Notional Air and Space Operations Center



Source: Department of the Air Force, Air Force Doctrine Document 2-1.7, *Airspace Control in the Combat Zone* (Washington, DC: GPO, 2005), 30.

Guidance from the JFACC is filtered through the appropriate liaison officers to ensure it is delivered to and executed by subordinate units that operate aircraft or those activities that will be impacted by air operations. Included in this JFACC guidance are directives that pertain to airspace management and, as indicated in figure 15, the BCD has a specific section dedicated to manage this piece of air operations and disseminate guidance to A2C2 elements.

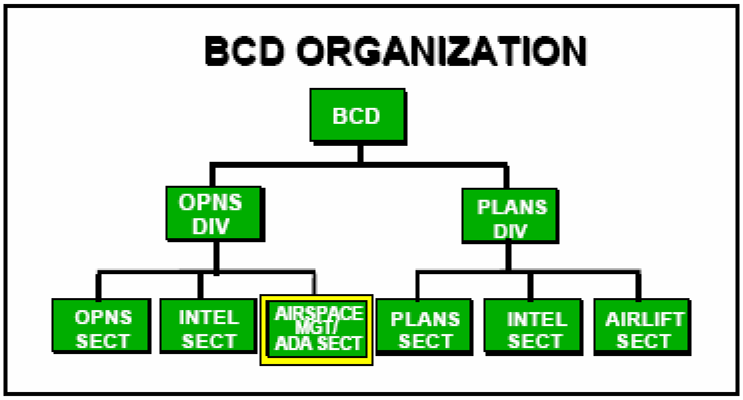


Figure 15. Battlefield Coordination Detachment Organization
Source: Air Land Sea Application Center, FM 3-100.2, *Multi-service Procedures for Integrated Combat Airspace Command and Control* (Washington, DC: GPO, 2000), A-8.

The JFACC provides additional guidance in the Joint Air Operations Plan, Special Instructions, and Air Operations Directive. As the ACA, the JFACC is responsible for providing guidance to all joint airspace users.[25] These products necessarily come from the same source because the procedures and reference systems used in them must be consistent to ensure safe and efficient airspace usage. The guidance they contain must be clear and consistent to both users and controllers of combat airspace. This guidance is passed from the JFACC via the BCD to the appropriate A2C2 element.

One of the unique considerations for UA operation is that UA are difficult to see, either visually or with radar. Because of this, joint doctrine calls for the ACO to contain detailed information about UA operations. This information will give all airspace users visibility on UA, including their operating times, locations, and altitudes.[26] This information provides situational awareness for planning and operations to UA users and manned aircraft crews.

JP 3-52 specifically addresses the issue of UA as they pertain to airspace control. This doctrine is not restrictive and leaves much up to the Services in terms of procedures. The joint doctrine allows each service to operate its UA within the precepts that establish airspace control.[27] The Army may operate its SUAVs below the CA with very little, if any, coordination with the JAOC or airspace control agency. This coordination requirement increases if the SUAV must fly above the CA. When this occurs, the users must contact and coordinate with the airspace control agency (ground radar facility or Airborne Warning and Control System).[28]

Air Force Airspace Control: The Theater Air Control System

Air Force doctrine is reflective of joint doctrine. Several foundational doctrine statements provide the basis for the Air Force perspective and the rationale for its Service doctrine. Airspace control is essential to combat effectiveness in accomplishing the JFC's objectives at all levels of conflict. As prescribed by joint doctrine, unity of effort enables the accomplishment of these objectives. The airspace control structure and procedures need to be simple to execute for both ground operations personnel and aircrews.

As the nation's only full-service air and space force, the Air Force is the primary user of airspace in most areas of responsibility or joint operational areas.[29] However, the Army is the primary user of airspace below the CA and the increasing presence of UA below the CA are imposing new restrictions on that airspace and forcing some control measures above the CA which limit joint force flexibility. Many of these restrictions are the result of ad hoc solutions which attempt to alleviate the symptoms of airspace

saturations, but not provide a cure. This reality is the lead-in for the next statement of Air Force airspace doctrine.

Airspace control structures and procedures require extensive planning before operations commence.[30] The absence of these structures and procedures provides the foundation for cumbersome ad hoc airspace control methods. These methods ultimately manage the issues but do not optimize airspace usage. The joint force must be able to plan and train to the level at which they will be required to operate in a joint operations area.

Army leadership and A2C2 must be prepared to provide its contribution because management of air operations is sometimes delegated. The ACA may assign a portion of the airspace to another commander to accomplish a specified mission. This option is executed via the non-JFACC ACA and is normally delegated to a ground maneuver unit commander with very specific lateral and vertical limits. The ground commander must have the C2 capability to manage an airspace sector before the ACA will grant this sector control.

The Air Force airspace C2 system is a reflection of the air and space power tenet of centralized control and decentralized execution.[31] The Air Force theater air control system (TACS) provides the Air Force component commander with the means to achieve this tenet. The Joint Air Request Network (JARN) illustrates the assignment of Tactical Air Control Parties to multiple echelons in the Army chain of command. The JARN is the process by which a Tactical Air Control Party helps communicate and manage Army requests for air integration. This process is portrayed in figure 16.

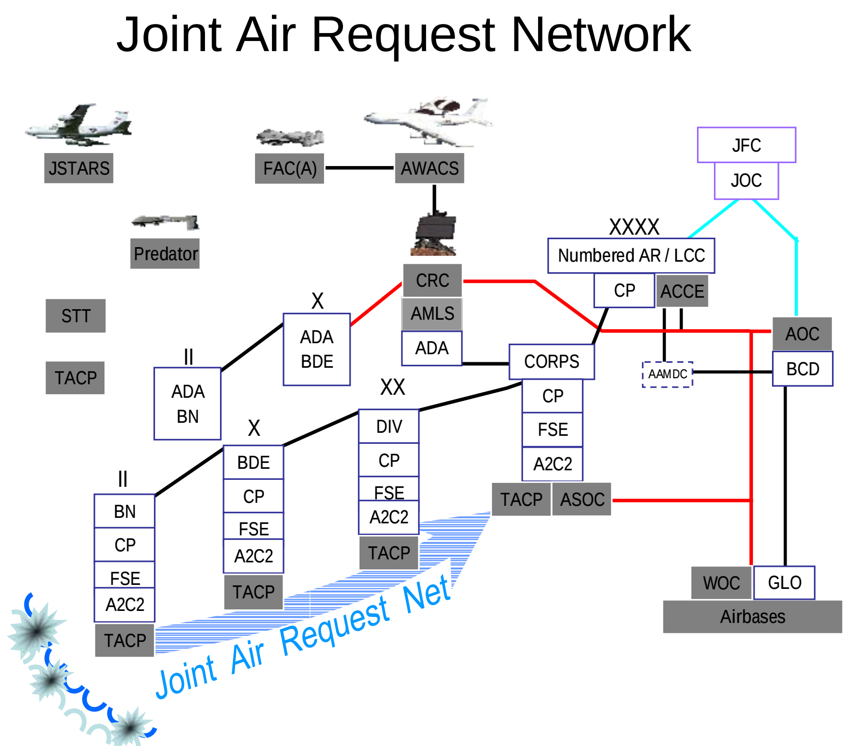


Figure 16. Joint Air Request Network
Source: Lt Col Richard Warren, USAF Element, Joint Firepower Course (Ft Leavenworth: U.S. Army Command and General Staff College, 2007).

The JARN is critical in providing the right fires when and where they are needed to produce maximum effect and provide necessary integration in the battlespace. Close coordination is the key to ensuring the process is successful. In addition, close coordination among airspace control, air defense, and air traffic control elements is required to maximize combat effectiveness while preventing fratricide and mutual interference.

Air Force doctrine also readily acknowledges the UA saturation issue. Regardless of size, UA operations require special considerations in terms of airspace control and

usage. Specific volumes of planned airspace for UA need to be included in the ACO, and operational UA information must be part of the theater ACP and special instructions.[32] Each service will have significant numbers of UA operating over or near friendly forces, airfields, and ports providing force protection or conducting reconnaissance, surveillance, or targeting missions. All UA missions need to be coordinated with the appropriate C2 agency prior to launch, ensuring effective deconfliction and integration with other airspace users. Although coordinated, small UA may not be included in the ATO or special instructions. These UA must be deconflicted on a real time basis with the appropriate airspace control agency. If UA operations are not deconflicted properly, unsafe flying conditions are likely, which may result in some airspace users being unable to accomplish their mission. Thorough coordination will ensure the safe separation of UA and manned aircraft, as well as preventing engagement by friendly forces.[33]

This statement clearly demonstrates a doctrinal acknowledgement of the UA issues, but does not specify how to resolve them. The specifics are more suited for inclusion in procedures and, since doctrine is not intended to be restrictive, Air Force doctrine recognizes the need for airspace control as it pertains to UA but does not specify how to accomplish it.

Air Force doctrine mirrors joint doctrine in its description of the establishment of the ACA. In a given scenario, the JFACC acts as the ACA for the JFC. The JFACC uses the ACP and ACO to govern the operation of the Theater Air Ground System.[34] The Theater Air Ground System is the collection of each component's airspace control systems used to integrate their operations.

The Air Force's TACS is organized on the principle of centralized control and decentralized execution.[35] Each level operates to accomplish its mission within given parameters, rules of engagement, and resources, and its operation is enabled by the C2 elements at that level.

Air Force doctrine treats the UAS as another weapon system and, perhaps most importantly, it views the UA as an aircraft equal to any other, regardless of its size. This is consistent with joint doctrine. The ACA, by means of the ACO, governs the use of the airspace--all airspace--by both manned and unmanned aircraft. The vehicle's size or owner is immaterial.

In the past, with the Army flying predominantly rotary-winged aircraft and the Air Force flying fixed-winged aircraft, a CA was used as a control measure to separate the two operating categories and allow them to successfully coexist. A CA is the altitude below which fixed-wing aircraft would normally not fly, and above which rotary-winged aircraft would normally not fly.

Traditionally, the Army or land component manages the airspace immediately above its AO and below the CA while the air component manages the airspace above the CA. The various elements of the Air Force's TACS provide this control above the CA, while A2C2 elements control the airspace below. As previously addressed, this is the airspace where saturation is a rapidly growing concern and where Army airspace management must handle the concerns while maximizing the available airspace.

Army Command and Control Organizations

Army C2 exists at each echelon of its command structure. A2C2 is just one among several C2 organizations (see figure 17) that maneuver commanders rely on to enable their operation.

C2 Organizations

- Command Post
- Fire Support Element
- A2C2 Element
- Army Air and Missile Defense Command
- ADA Brigade
- Special Operations Component

Figure 17. Army Command and Control Organizations
Source: Department of the Army, Field Manual 3-52, *Army Airspace Command and Control in a Combat Zone* (Washington, DC: GPO, 2002), 2-7.

Army Airspace Command and Control

Army doctrine, as it pertains to airspace control, is explained by the A2C2 structure. A2C2 is organized consistent with the Army's guiding principles of "centralized planning, decentralized control and decentralized execution."[36] As with other Army C2 components, the A2C2 system is comprised of elements in command posts from the Theater Army level to brigade level, with ad hoc elements formed at the battalion level.

Air Defense Airspace Management/Brigade Aviation Element

The Army's transition to modularity resulted in numerous organizational changes. The two most profound changes, as far as Army aviation is concerned, are the development of A2C2 at the BCT level and the fact that each maneuver BCT now has its own organic aviation assets (UA). Modularity focuses on the BCT as the primary unit of employment and has augmented the BCT beyond previous traditional brigade capability. This augmentation to A2C2 within the BCT is the Air Defense Airspace Management and Brigade Aviation Element (ADAM/BAE).

The previous brigade construct for A2C2 was ad hoc. The new organization provides a consistent, organic, trained A2C2 function to enable BCT aviation operations. The ADAM/BAE is now doctrinally an integral part of the aviation C2 equation, because of the focus on BCT capabilities and operations. The ADAM/BAE is an integral part of the Army's concept to transition the entire force from its Cold War model to a force capable of the rapid deployment, flexibility, and functional warfighting capability organic to each BCT. These characteristics of the current and future Army Aviation force are depicted in table 9.

Table 9. Correcting Capabilities Imbalances in Army Aviation

ARMY AVIATION: CURRENT AND FUTURE FORCE

Current Force	Future Force
• Linear, echeloned organization	• Modular organization
• Cold War doctrine	• Capabilities concentrated at the UEx and aviation elements within every BCT(UA)
• Concentrated at Corps	• Standard formations with common unit sizes, basis of issue, manning, SOPs and METLs
• Uniquely organized and equipped to support the different division designs (heavy, light, airborne, air assault)	• Improved sustainment and supportability
• Lift deficient at lower echelons	• Improved airspace control
• Attack deficient within heavy forces	
• Slow to deploy	

Source: Department of the Army, *Army Transformation Roadmap 2004* (Washington, DC: GPO, 2004), 3-10.

The ADAM/BAE is the entity which provides this future force vision to the aviation piece of the BCT. Its tasks are relatively standard A2C2 functions; the biggest difference with the ADAM/BAE is that their A2C2 functions are now organic to the BCT and no longer ad hoc. Each echelon of A2C2 generally executes the same types of tasks. These tasks are layed out in table 10.

Table 10. Primary Army Airspace Command and Control Tasks

Primary A2C2 Tasks

- Develop and coordinate airspace control SOPs, plans, and A2C2 annexes to the base order.
- Identify, consolidate, coordinate, and integrate airspace user requirements within the AOA.
- Coordinate and integrate airspace use within the AOA with other Services and adjacent units.
- Identify and resolve airspace user conflicts.
- Staff and forward requests for special use airspace to the next level for approval.
- Maintain A2C2 information displays, overlays, and maps with ACM, FSCM, and known hazards.
- Receive and disseminate ACMs and directives from higher headquarters, then integrate and implement ACA-approved ACMs affecting the maneuver commander's AOR.
- Incorporate ACMs in the scheme of maneuver during the planning phases by making A2C2 part of the commander's course of action decision criteria.
- Seek commander's guidance on A2C2 priorities by mission type or battlefield operating system or geographic area of operations or time/phases of the operation.
- Monitor planned airspace user operations and correlate situations affecting airspace use for immediate, unscheduled events such as MEDEVAC missions or ATACMS launches.
- Maintain ADA and artillery firing locations.
- Monitor subordinate unit plans for aircraft in/out procedures at FARPs, RRPs, FAAs, Route SPs, and RPs.
- Disseminate changes to the air defense weapons control system.
- Monitor early warning control measures to deconflict friendly airspace user operations.
- Monitor status of supporting airfields, navigational aids, and air traffic services facilities.
- Monitor air support requests for organic helicopters and assign mission control numbers.

NOTE: Normally the G3/S3 Air is designated the approving authority for and submits preplanned aur support requests (DD Form 1972).

Source: Air Land Sea Application Center. FM 3-100.2, *Multi-service Procedures for Integrated Combat Airspace Command and Control* (Washington, DC: GPO, 2000), A-9.

The difference between the various echelons is the size of the A2C2 element and the scope of their activity (BCT versus Corps, for example). The variable among the different A2C2 elements is the scope of responsibility within which these tasks must be carried out. This scope is defined by the specific echelon in which each A2C2 element is located, and can be quantified by the size of its unit's AO, number of organic assets, number of sorties in a given time period, and amount of control measures executed.

The numerous tasks of A2C2 provide a snapshot of its spectrum of responsibilities. With a growing number of airspace users and UA, these responsibilities

are growing and becoming more complex. A depiction of the players in an A2C2 element is indicated in table 11 and provides further context for the role of A2C2.

Table 11. Army Airspace Command and Control Element Representatives

A2C2 Element Representatives

- ADA Element
- Aviation Element
- Air Liaison Officer
- Fire Support Element
- ATS Company—supporting the unit at division and higher level
- Military Intelligence Unit
- G2 Section and UAV Chief
- G4 Section
- Marine Corps Air or Naval Gunfire Liaison Company, when required

Source: Department of the Army, Field Manual 3-52, *Army Airspace Command and Control in a Combat Zone* (Washington, DC: GPO, 2002), 2-8.

An illustration of this A2C2 structure in action is shown in figure 18. As depicted, Army airspace managers and operations representatives exist at each maneuver unit echelon of command.

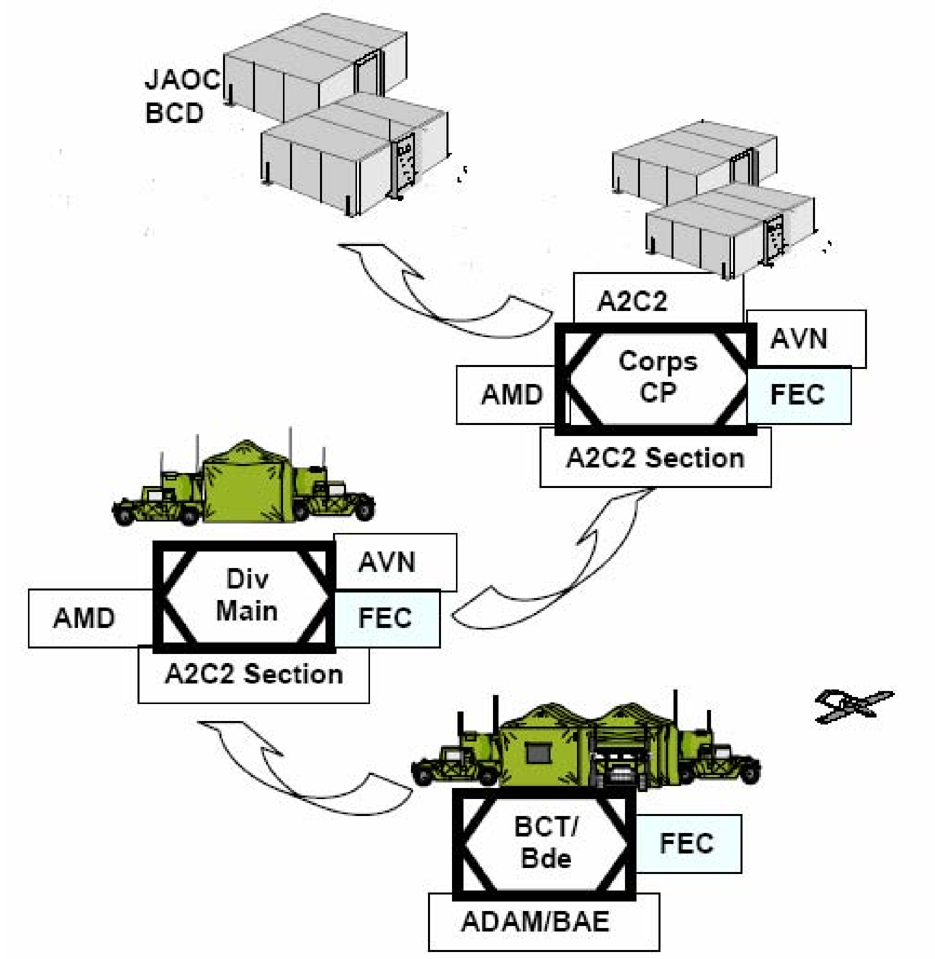


Figure 18. Modular Army Airspace Command and Control Structure
Source: Briefing for Army Airspace Command and Control in the Modular Force, TRADOC PIO, Battle Command-A2C2, 29 April 2005.

These elements assist the commander at each echelon in executing the plan for Army users of the airspace, especially the airspace above the individual AOs. At the BCT level, the following are the specific tasks that the ADAM/BAE conducts to integrate UA operations: provide oversight of both Raven (SUAV) and Shadow (Tactical Unmanned Aerial Vehicle) operations, assist battalions with training for and planning of UA missions, request ACM from the Air and Space Operations Center to integrate UA

operations, and coordinate with BCT Intelligence (S-2) for Tactical Unmanned Aerial Vehicle missions.[37] A2C2 is still an ad hoc function at the Battalion level, but is normally accomplished by the Battalion Operations Officer (S-3) and his staff.

For the most part, airspace control from the ADAM/BAE still relies heavily on procedural control. This is accomplished via procedural control measures. A2C2 ACM are relatively predetermined, in contrast to the Air Force's TACS. The Army emphasizes decentralized procedural airspace control so that it can avoid control procedures reliant on voice communications. The TACS uses both procedural and positive control but, unlike the Army, primarily employs control in "real time," which is enabled by persistent voice communications. The Army generally avoids positive control because it is not organized, trained, and equipped to execute it. The ADAM/BAE is certainly a significant increase in A2C2 capability but, by itself, does constitute the personnel and equipment to vastly increase the potential for positive control. Because the different approaches offer similarly differing "timeliness," the potential exists to reduce the effective use of joint airspace.

The need for real time airspace control is illustrated in figure 19. It depicts UA integration with a maneuver brigade. Figure 19 illustrates the result of organic BCT UA. There is little doubt that the BCT commander's immediate intelligence requirements are serviced with this capability, but clearly that can only be achieved through intricate planning, disciplined execution, and significant C2 capability. The need for this level of C2 at the BCT level is the driving force behind efforts to enable BCTs with the organic capability to provide more positive control, rather than relying almost entirely on

procedural control which would be inflexible and largely unresponsive to the extremely dynamic situation portrayed in figure 19.

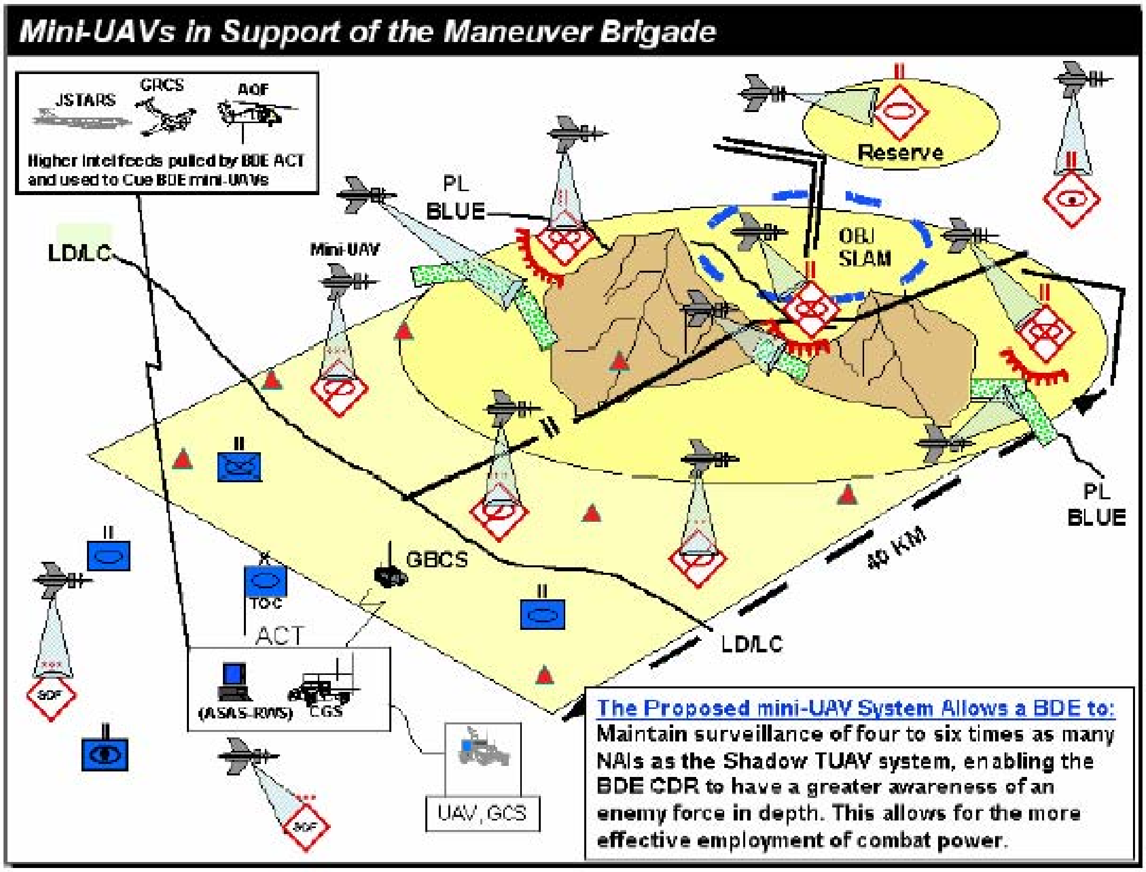


Figure 19. Mini-UAVs Integrated with the Maneuver Brigade
Source: Shawn C. Weed, "The Quality of Quantity: Mini-UAVs as an Alternative UAV Acquisition Strategy at the Army Brigade Level" (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 2002), 40.

Recent enhancements by the 4th Infantry Division operating in the vicinity of Baghdad, Iraq have helped to provide a foundation and a key set of lessons learned by which other Army units and commanders can help usher in more positive control. The

current operating procedures highlighted below focus on the innovations of the BCTs of the 4th ID rather than on traditional A2C2 which functions almost exclusively via procedural control.

Current Operating Procedures

In the contemporary operating environment of OIF, recent A2C2 innovations have been made at the division level to increase the potential for positive control within organic Army airspace control assets. In Baghdad, the division A2C2 cell moved from a legacy system which relied on analog information distribution to a digital system which allowed for real time distribution of airspace information.[38] This information was used to accomplish real time coordination.

Since the primary area of airspace concern is the low level structure, the division A2C2 element combined available BCT radars and utilized them in concert with the Tactical Airspace Integration System to provide real time low-level airspace awareness. This is a key area of concern for BCT A2C2 because organic BCT UA (operating below the CA within the BCT AO) must be deconflicted from other organic flying assets. The real time situational awareness provided by these radars is a significant step in the enabling of deconfliction within the low altitude structure.

This division-level A2C2 innovation with real time coordination and real time situational awareness had not previously been accomplished by an A2C2 element. The efforts of the 4th ID in the fall of 2006, indicate that Army doctrine will have to consider and include an expanded role for A2C2 elements with the impending surge in organic UA. The BCTs' A2C2 elements utilized new procedures to improve the flexibility and efficiency of the airspace in which the division was operating. This ultimately assists the

JFC because, by increasing safety and efficiency in the airspace, combat effectiveness (the goal of combat airspace control) was enhanced.

According to FM 3-52, *Army Airspace Command and Control in a Combat Zone*, the senior Army tactical echelon is responsible for publishing an airspace C2 annex to the OPLAN. This annex is referred to as ANNEX O, and it delineates A2C2 procedures to be used by all Army airspace users in theater. In addition, the Aviation Procedures Guide provides airspace guidance within an Army AO.[39] In the current environment, ANNEX O is not always published. Without it, Army divisions were left to manage airspace by employing their own systems and communications which are often not interoperable with other Army or joint systems. This deficiency can have obvious negative effects on mission effectiveness. Established ANNEX O guidance can also allow Army units to incorporate theater systems and guidance into their pre-deployment training.[40]

FM 3-52 currently identifies the Division A2C2 cell as central to the control of airspace within their AO.[41] Because the Army's unit of focus in modularity is the BCT, new doctrine will likely redefine the BCT A2C2 cell as being central to the control of airspace in its respective AO. BCT A2C2 cells, in concert with the other BCTs within their division, can provide sector control if they can identify and communicate with aircraft in their AO. This requires the integration of their organic digital systems to provide real time awareness which will enable real time coordination with other agencies and cells.

The CRC uses both positive and procedural control to deconflict aircraft above the CA. It also controls airspace below the CA if a high priority mission requires that airspace.[42] BCT A2C2 requires constant communication with and situational awareness

of the CRC's activities. Persistent communication enables the BCT to respond to CRC information in real time. This is especially true when managing surge operations or periods of congestion within the BCT and division AO below the CA.

Congestion problems below the CA have caused some Army leaders to move it higher. In recent combat operations, it was established at 3,000 feet AGL, and has gone as high as 10,000 feet AGL in some scenarios, with requests to move it as high as 15,000 feet AGL. The very high CA makes it extremely difficult, if not impossible, for aircraft conducting Close Air Support and airlift operations to accomplish their missions.[43]

The BCTs of the 4th ID in OIF were able to reduce the potential for imposition on other mission areas by conducting operations with a 3,000 feet AGL CA and using existing systems (radars and communications) in an innovative manner to provide low altitude battlespace awareness. The information processed and disseminated as a result allowed the BCTs to maximize the airspace below the CA while conducting safe and efficient air operations in the complex and dynamic air environment that is characteristic of stability operations.

Next, chapter 3 will discuss the methodology utilized to conduct this research.

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[1]John T. Correll, "Recasting the Vision," *Air Force Magazine* 83, no. 8 (2000): 14; available from http://www.afa.org/magazine/aug2000/0800edit.asp; Internet; accessed on 15 October 2006.

[2]Office of the Secretary of Defense, *Roadmap 2005-2030*, 29.

[3]Ibid., 26.

[4]Ibid., 8.

[5]Ibid., 4.

[6]Ibid., 6.

[7]Department of the Army, Field Manual 3-52, *Army Airspace Command and Control in a Combat Zone* (Washington, DC: GPO, 2002), 4-13.

[8]Chairman, Joint Chiefs of Staff, Joint Publication 3-52, *Joint Doctrine for Airspace Control in the Combat Zone* (Washington, DC: GPO, 2004), II-1.

[9]Chairman, Joint Chiefs of Staff, Joint Publication 1-02, 25.

[10]Neuenswander.

[11]Chairman, Joint Chiefs of Staff, Joint Publication 3-52, II-2.

[12]Ibid., II-3.

[13]Ibid., II-5.

[14]Ibid., III-3.

[15]Ibid., IV-2.

[16]Ibid., I-3.

[17]Ibid.

[18]Ibid.

[19]Ibid.

[20]Ibid., II-3.

[21]Neuenswander.

[22]Department of the Army, Field Manual 3-52, 4-45.

[23]Chairman, Joint Chiefs of Staff, Joint Publication 3-52, III-3.

[24]Neuenswander.

[25]Department of the Air Force, Air Force Doctrine Center Handbook (AFDCH) 10-01, *Air and Space Commander's Handbook for the Joint Force Air Component Commander* (Maxwell AFB, AL: Air University Press, 2005 Revision), 49.

[26]Chairman, Joint Chiefs of Staff, Joint Publication 3-52, II-6.

[27]Ibid., III-4.

[28]Neuenswander.

[29]Department of the Air Force, Air Force Doctrine Document 2-1.7, *Airspace Control in the Combat Zone* (Washington, DC: GPO, 2005), 6.

[30]Ibid., 12.

[31]Ibid., 28.

[32]Ibid., 27.

[33]Ibid.

[34]Ibid., 29.

[35]Ibid.

[36]Department of the Army, Field Manual 1, *The Army* (Washington, DC: GPO, 2005), 1-12.

[37]Neuenswander.

[38]Ibid.

[39]Department of the Army, Field Manual 3-52, 3-12.

[40]Neuenswander.

[41]Department of the Army, Field Manual 3-52, 3-14.

[42]AFDCH 10-01, 37.

[43]Neuenswander.

CHAPTER 3

METHODOLOGY

The methodology used to accomplish this research consists of a doctrine literature review as well as an examination of how this doctrine bears on the UA deconfliction and airspace control issues. The Joint and Service doctrine provides the foundation upon which current airspace control procedures are formulated and executed. Once the doctrine and procedures were evaluated, the findings of the OIF-Operation Enduring Freedom (OEF) Airspace Command and Control Collection and Analysis Team (CAAT) were overlaid onto them. The CAAT conducted a comprehensive examination of airspace issues in both Iraq and Afghanistan in the fall of 2006. The purpose of examining doctrine, procedures, and the CAAT findings was to determine if gaps existed in either doctrine or procedures, or if updated doctrine would be required to develop new procedures to deal with the emerging airspace control issues.

The literature review primarily examined the doctrine (both Joint and Service) that bears most critically on the topic of airspace control. For the most part, selection of sources was limited to those doctrine documents that relate directly to the UA deconfliction issue. To verify the relevance of these chosen publications, they were confirmed via the Joint Unmanned Aircraft System (JUAS) Center of Excellence at Creech Air Force Base in Indian Springs, Nevada. The JUAS Center of Excellence is the Defense Department’s executive agent for UA employment and its related issues.

Initial doctrine review consisted of broad joint guidance contained in Joint Publication 1, *Joint Warfare of the Armed Forces of the United States*, and 3-0, *Joint Operations*. While no specific references to airspace control is made in these documents,

they outline basic fundamentals of joint operations that must be nested within the solutions for airspace control issues.

The next area doctrine addressed was specific joint doctrine regarding airspace control, JP 3-52, *Joint Doctrine for Airspace Control in the Combat Zone*. This is more specific than the broad joint guidance and forms the framework which supersedes Service doctrine. After examining the airspace control principles according to joint doctrine, the specific Service doctrines (Air Force and Army) were reviewed to determine if they were at all inconsistent with Joint doctrine, incomplete in satisfying Joint doctrine, or required updates that would drive new airspace control concepts or measures to cope with the impending UA boom.

Once both Joint and Service doctrine was reviewed and analyzed, the OIF-OEF CAAT findings were evaluated to determine if current airspace control operations were consistent with doctrine or if existing procedures to manage airspace required doctrinal updates. If a need for updated or new doctrine is identified, this has significant implications because doctrine helps determine the roles, authority, and resources to accomplish a given military mission. The way ahead for airspace control is a flexible architecture capable of handling an increasing number of airspace users, thereby maximizing finite airspace. This requires that several entities receive expanded roles, increased authority, and greater resources to conduct airspace control.

To bring the research full circle, the reviewed doctrine, procedures, and CAAT findings were used in the initial portion of chapter 4, “Conclusions and Analysis,” to answer the tertiary, then secondary, and finally primary research question posed in chapter 1. Subsequent to those answers in chapter 4, general conclusions were made with

regard to airspace control. The answered research questions and conclusions in chapter 4 provided the lead-in to chapter 5, which contains the recommendations. These formulate proposals for both Joint and Service doctrine and procedures that can be improved, updated, or created to provide safe and effective airspace control in the future battlespace that will be host to a significant number of UA.

CHAPTER 4

CONCLUSIONS AND ANALYSIS

Conclusions

Given the review of doctrine and procedures, the following conclusions can be made with regard to UA and their control, deconfliction, and coordination. As evidenced by the end of chapter 2 with a look at current operations in OIF by the 4th Infantry Division's BCTs, a lot of progress was made by increasing the level of positive control by organic A2C2 elements, thus enabling BCT sector control. The following conclusions will help provide the context within which the research questions will be answered.

A2C2 cells are not always interoperable; interoperability often depends on what theater they are deployed to and what equipment they are using.[1] This potential lack of interoperability coupled with an absence of IFF or data capability on many currently fielded UA yields a gap in the situational awareness of A2C2 at multiple levels and denies them the ability to provide a COP. Ground radars are essential to help fill this void, but they must be organic to the BCT's A2C2 elements that utilize them. A major challenge is that their personnel must receive constant training on the systems in order to establish the necessary awareness upon arrival in theater. In addition, these radars must be compatible with the equipment operated by other BCTs, especially within the same Corps, to allow the individual BCT Common Operational (or Operating) Picture (COP) to augment the Division COP. Ideally, the future of the COP rests in data links, which are far less cumbersome than organic ground-based radar systems.

In addition to a COP provided by data link and ground-based radar information, persistent voice communications are required between UA operators and A2C2 cells.

This capability will require a robust acquisition effort by the Army to meet the requirements of increased positive control. Procedural control is inherently less flexible than positive control and far less capable, by itself, to deal with the dynamic airspace requirements of major combat operations and especially of stability operations. Stability operations introduce a wealth of airspace users (airlines, commercial lift, other government agency aircraft, non-governmental organization aircraft, news agencies, and others.) into the equation which are not present during major combat operations.

This reality illustrates the imperative to treat all aircraft equal when it comes to deconfliction. A midair collision with a UA can be just as catastrophic as a collision between two manned aircraft. In addition, at the speeds that many aircraft travel, it does not take a large aircraft to inflict fatal damage upon another in a collision.

These conclusions establish the context within which the research questions will be answered.

Revisiting and Answering the Research Questions

In chapter 1, the research questions were identified. The questions are as follows:

Primary Question: What doctrine and procedures can be applied to impending UA battlespace saturation to allow for their safe and effective employment?

Secondary Questions:

1. What is the existing airspace control architecture and how will it need to evolve to handle the saturation?

2. How do UA fit into this architecture?

3. What is the current doctrine that governs airspace control?

4. Is the current doctrine satisfactory to handle the UA issue?

5. Do the Services have different points of view on UA operation?

6. What types of UA will be operated and what portion of the airspace is most affected by their presence?

7. What will be different about employing UA across the spectrum of military operations (major combat operations employment versus stability operations employment)?

8. What types of control will be most effective at deconflicting them?

Tertiary Questions:

1. How can UA interrogation (IFF) or data link be utilized to provide control and deconfliction of UA assets?

2. Will all UA types have some form of IFF or data link capability?

3. If not, what is the solution for those without it?

4. Where should this positional information be transmitted to and at what level should overall control exist?

5. What level of coordination should exist among UA users?

6. Can one UAS gather appropriate information for multiple users without a “competition” for the same airspace?

In order to ultimately answer the primary research question, the tertiary and secondary questions will be answered first. Their answers build up to the conclusion of the primary question. The secondary and tertiary questions are more specific in nature and are the building blocks upon which the conclusions and recommendations regarding the primary research question is based.

Tertiary Questions

How can UA interrogation (IFF) or a data link be utilized to provide control and deconfliction of UA assets? IFF and or data link capability on airborne assets give C2 elements visibility on them and, in turn, the ability to provide real time control and deconfliction. While doctrine and procedures are enhanced by the Services to provide airspace control in an increasingly congested airspace situation, UA requirements and procurement efforts must ensure an IFF and or data link capability so that future acquisitions consist of UA that can have visibility and interoperability in a COP. This picture provides C2 with the requisite situational awareness required to manage the airspace.

Will all UA types have some form of IFF or data link capability? If not, what is the solution for those without it? The lack of IFF or data link capability is not an issue with larger Army UA (Class III and IV) or Air Force UA for two reasons. First, these aircraft are large enough to physically handle an IFF or data link equipment package on their airframe and, because of their size, are required to have one. Second, these UA, based on operating profile, often execute missions above the CA so they not only have ATO visibility, they also are more easily tracked because they operate at higher altitudes while transmitting positional information to control facilities.

The issue is that approximately two-thirds of the future UA fleet will be made up of Class I and II UA.[2] These aircraft are not currently programmed to have IFF or data link capability and, to compound the problem, they normally operate at or below 1,500 feet AGL. As stated, the CA in Iraq right now is 3,000 feet AGL so the majority of UA will be operating below the CA without IFF or data link. For these UA, organic A2C2

elements must be able to provide the minimum amount of procedural airspace control to provide other airspace users with visibility on their operations.

Where should this positional information be transmitted to and at what level should overall control exist? Positional UA information must be transmitted to the C2 entities that are responsible to manage the airspace within which a given UA is operating. This will vary based on where the UA is employed and at what altitude.

What level of coordination should exist among UA users? Ideally, UA users will be able to identify the pieces of airspace they will likely be required to operate in and ascertain both who manages that airspace and who (based on how forces are arrayed and unit boundaries are drawn) will operate in or near that airspace. Perhaps the greatest piece of coordination for the SUAS users below the CA is the relationship not with other UA users necessarily, but with the accompanying helicopter units and the A2C2 element to understand the procedural controls which will be used to deconflict them.

Can one UA gather appropriate information for multiple users without a "competition" for the same airspace? It depends. The Army is equipping its units with organic UA for a reason. An organic entity can be employed by its unit's leadership when needed, where required, and for their purpose. The coordination piece required is lessened, or even eliminated, by not needing to consult with any outside entity to employ the UA. The inherent availability and flexibility of having organic UA is perhaps their greatest benefit. With this flexibility, however, comes responsibility.

In theory, an Army commander at almost any level could launch a UA sortie any time he or she feels the need to collect information on (or strike) a target. If, however, every Army commander operates his or her UA with this philosophy, the potential for

chaotic airspace would become a reality, especially when the nominal future BCT will own 212 of its own UA. Discretion and cooperation must always enter into the decision matrix of whether or not to launch a UA. The target of interest may well have implications for the neighboring platoon, company, battalion, BCT, or brigade, and one UA could accomplish the task that two or three were intended to launch against. Just as those same units would coordinate fires and maneuver across, or near, their AO boundaries, the UA operators have a requirement to do the same.

Additionally, one UA could potentially integrate with multiple tactical users by transmitting specified data to each user or, by utilizing multiple sensors, or one UA could gather information on multiple targets simultaneously. Establishing a working relationship with neighboring units will have a variety of positive effects. One of them is the potential to decrease the burden on busy airspace through coordination.

The Air Force construct for this scenario is a bit different. Air Force UA are owned and operated by strike and or reconnaissance squadrons whose assets are tasked via the ATO process and, by definition, have multiple customers based on the scenario and the requirements. In other words, Air Force UA do not operate solely for one unit or another. The effects of these critical, limited resources are intended to benefit the units across the joint force, that need them most.

Secondary Questions

What is the existing airspace control architecture and how will it need to evolve to handle the saturation? The existing airspace control architecture consists of a variety of entities that use a myriad of processes and products to provide airspace control. Ultimately, the JFACC (as the ACA) is responsible for this control within the JFC’s

airspace. The focus of UA deconfliction exists in the low altitude structure below the CA. This airspace is normally managed by the ASOC. With the tremendous number of UA programmed into the FCS concept, the ASOC will need to enable A2C2 to manage the airspace below the CA.

How does the UA fit into this architecture? The UA is doctrinally placed on the same level as any other aircraft with respect to the need to provide deconfliction. The fact that many UA are very small (just a few pounds in some cases) does not lessen the requirement to provide control and deconfliction from them. Specifically, because of the Army's proliferation of these very small UA, they will largely operate below the CA within a division AO. This means that they will be provided with procedural control by the division A2C2 element which will implement those in accordance with the ACA's ACM.

What is the current doctrine that governs airspace control? Is current doctrine satisfactory to handle the UA issue? The doctrine that governs airspace control is reviewed in chapter 2. It consists of a variety of joint and Service documents that provide the foundation for current procedures. Joint and Air Force doctrine is comprehensive in its guidance for airspace control but, because a large piece of the proposed recommendation hinges on positive control, Army doctrine will need to be updated to provide the resources, personnel, and training for A2C2 elements to have the authority and increased role of airspace control.

Do the Services have different points of view on UA operation? The Army and Air Force ultimately have the same result in mind when it comes to UA operation: on-call actionable intelligence and or precision fires provided by a stand-off asset. Their methods

of employment differ by who operates them and, based on the variations of Service UA, where and how they are employed. The Air Force inherently operates its UA within the framework of the other systems and missions that are going on around it. The Army, with many of its UA operators at the tactical level and not having visibility on the rest of the air picture, might assume that their mission is always the most important one and not understand the very complex and busy architecture in which they operate.

What types of UA will be operated and what portion of the airspace is most affected by their presence? UA vary from the very small, hand-launched Class I proposed as part of the Army FCS concept to the very large RQ-4 Global Hawk sporting a wingspan of 116 feet and a weight of nearly 33,000 pounds.[3] In general, size is proportional to the altitude at which these systems will operate. Of significance to this thesis is the fact that the majority of current and proposed UA are those in the small UAS category that can be launched without the use of a runway and operate below 2,000 feet AGL. These specifically are the UA that threaten to clutter the airspace below the CA and represent enduring hazards.

What will be different about employing UA across the spectrum of military operations (major combat operations employment versus stability operations employment)? Both major combat operations and stability operations will experience significant UA participation in the battlespace. In recent history, major combat operations have been relatively brief when compared to the span of stability operations. The implications of these timelines are significant. While major combat operations certainly require safe and efficient airspace control to enhance the combat effectiveness of the joint force, stability operations introduce an entirely new set of airspace users to include other

government agencies, non-governmental organizations, commercial passenger and cargo carriers, and other host nation aviation entities, such as media. This will require the opening of the airspace structure to integrate with them, which further reduces the airspace available to the joint force and provides additional impetus for maximizing the potential of the remaining portions of airspace. The bottom line is that UA need to be able to operate within this framework or they will become a liability.

What types of control will be most effective at deconflicting them? The answer is both positive and procedural control, but more positive control is needed in the existing and future airspace architecture to optimize airspace usage and mitigate the risk associated with very busy airspace. Current airspace control is a blend of both positive and procedural control. Procedural control certainly has its merits and will remain an integral part of airspace control methods. Future airspace will certainly include both positive and procedural measures, but procedural control now is used as a crutch to provide some degree of control in situations where positive control would truly enhance combat effectiveness, but the capability to provide it does not exist.

Primary Question

What doctrine and procedures can be applied to impending UA battlespace saturation to allow for their safe and effective employment? The answer to this question is extensive. Updated Army doctrine is required to provide A2C2 elements with the personnel, equipment, training, and authority to provide more positive control. This updated doctrine will provide the framework within which more effective and efficient airspace control can be exercised. The Army will procure the majority of UA in the future. These assets are organic to the BCTs and will integrate with Army maneuver

units. A2C2 must be tasked, organized, trained, and equipped to provide C2 to these rapidly growing Army assets.

UA saturation is certainly a joint issue, but each of the Services must contribute individually to solving it. The Army must provide the organic C2 of its own assets to ensure it can assist in bringing overall efficiency and effectiveness to the greater airspace architecture. The way to do this is to update doctrine and procedures that will usher in an emphasis on positive control of Army airborne assets provided by Army C2 organizations. From a practical standpoint, because the Army's UA are the most numerous systems operating below the CA, the Army must be part of the management solution and not just add to the problem by introducing more and more UA in the JFC's airspace.

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[1]Neuenswander.

[2]U.S. Government Accountability Office, GAO-06-610T, 6.

[3]Air Land Sea Application Center, FM 3-04.15, *Multiservice Tactics, Techniques and Procedures for the Tactical Employment of Unmanned Aircraft Systems* (Washington, DC: GPO, August 2006), II-5.

CHAPTER 5

RECOMMENDATIONS

The Way Ahead

The way ahead for airspace control and UA deconfliction, in response to the tremendous increase of UA in the battlespace, has numerous implications. Because the primary area of concern is airspace below the CA within a BCT AO, the role of A2C2 is significant and its responsibilities will increase beyond those of the existing ADAM/BAE.

Some have argued that if the airspace congestion problems are most prevalent below the CA, raising the CA will open up more airspace and ease the congestion. The congestion, however, is caused primarily by various UA types and helicopters operating within the same altitude band (1,000 feet AGL and below), not at the maximum ceiling of the CA. In other words, a CA of unlimited altitude does not change the fact that Class I UA and Army helicopters are generally operated at and below 500 feet AGL. In addition, raising the CA significantly impacts the JFACC's ability to provide critical mission integration (such as Close Air Support and Airlift) with ground forces. The answer does not lie in "more" airspace, because ultimately airspace is a finite resource. Because of this, the answer lies in more efficient use of the existing airspace.

The way ahead for UA control, deconfliction, and coordination lies in positive control. Future airspace control will still include a mixture of both positive and procedural control, but positive control provides the real time flexibility to both keep UA operations safe and deconflicted as well as maximize their potential in the battlespace. Limiting procedural control, which can only be done by increasing the capability to

exercise positive control, will remove many of the control measures (Restricted Operating Zones, and others) which clutter and restrict the JFC’s airspace. The joint force has an obligation to leverage its C2 potential and information technology advantage to bring efficiency to the airspace. As this digital capability continues to increase, it must continue to be leveraged against the parallel increase in UA to maintain effective management of the battlespace. This means continuing to strive for positive control initiatives.

A2C2 elements at all levels (Corps, Division, and BCT) need consistent training and guidance, as well as interoperable equipment. This training and guidance needs to match the rules of engagement that is employed in theater so A2C2 elements can provide immediate and appropriate airspace control upon their arrival in that theater. The interoperable equipment requirement has two aspects; the systems employed in theater must be available at home station for training and they must be able to link with other A2C2 elements when tactically employed so a larger COP can be established to provide situational awareness. A2C2 elements must also be given the opportunity to train with ASOC members so that standard operating procedures as well as relationships can develop between these personnel.

The COP can only be established if A2C2 elements are equipped with organic ground control stations and radars. If each division is given the resources required to develop this picture, each of its BCTs can access and augment the information provided to give BCT A2C2 the situational awareness required to control its piece of the AO. In turn, the overall division picture can be fed to Corps level A2C2 to provide a comprehensive air picture of the assets it controls.

In order for UA to be visible on this COP, they require the means to transmit positional information to its host. This is most effectively accomplished by outfitting UA with IFF or a data link. Because some of the small UA (Class I and II) already fielded do not have this capability, they will require the procedural control measures which keep other aircraft (especially manned aircraft) clear of them. However, the amount of UA operated under procedural control must be limited in order to maximize finite airspace and provide both the UA operators and airspace controllers the most benefit from each UA sortie. The larger UA that have either the IFF and or data link or the radar cross section large enough to be visible on the COP can be operated under positive control. The bottom line is that the ability to positively control UA must be consciously designed and built into each UA platform. For this reason, future UA procurement must make IFF and or data link a requirement. With circuit miniaturization, this is now possible on even the smallest of UA.

Because the UA of primary concern to this research operate at relatively low altitudes, line of sight could potentially be an issue for the IFF and data link transmitters. To remedy this, BCT A2C2 should be tasked to provide data link antennae for their organic assets. Additionally, as progress with the high altitude airship concept continues, one of its future roles could be as a data link relay for low altitude aircraft.

As a result of A2C2 interoperability, some degree of coordination among UA operators within a Corps or Division should emerge. The likelihood exists that a given BCT will require a UA sortie on a target that is also of interest to a neighboring BCT. Coordination between the A2C2 elements of each BCT could allow one UA sortie to accomplish the desired mission for both BCTs. Coordination, enabled by A2C2

interoperability and visibility on a COP, could lead to more efficient use of UA and ease the burden on finite airspace. The end result would be decreased airspace saturation, reduced requirement to deconflict UA employment, and increased availability of UA for other missions.

UA deconfliction requires a variety of elements. The COP provides a centralized situational awareness node to A2C2, but this information will not normally be available to UA operators. In order to link the operators to A2C2 to establish real time, positive control, communications are needed. The recent success (fall 2006) of the 4th Infantry Division A2C2 providing real time control was enabled by its communications capabilities.[1] A2C2 elements must have organic voice and digital communications to communicate with UA operators in real time and transmit control and deconfliction guidance to them.

UA deconfliction hinges on visibility. This visibility has to occur in multiple places, both prior to and during its employment. The prior visibility is established at the planning stage. All joint force UA that are Class III and IV must be included on the ATO. This means, perhaps most importantly, that ATO aircraft are required to operate in accordance with the ACO and special instructions. Even though this is a requirement now, these larger Army UA do not always show up on the ATO because of a lack of pre-planning or prior coordination.[2] When this happens and that specific UA mission is given priority, additional procedural control measures are required to give that mission the airspace and time it needs. Pre-planning and coordination can alleviate the need to place restrictive, last minute control measures in the airspace. This pre-planning step will not be possible in all situations, such as when a Class I or II UA is needed by a company

commander for a pop-up target. These types of situations can be expected, but they should happen as a result of the fog of war, not from a lack of pre-planning or coordination.

It has been said that with the advent of the FCS, every BCT is now an aviation brigade. This statement has significant ramifications. With specific regard to aircraft deconfliction, adherence to positive control directives and deconfliction rules of engagement by UA users must be established. For the most part, Army UA operators are not aviators by trade. Their lack of aviation experience has resulted in some misunderstandings of the airborne environment which have manifested themselves in a significant number of procedural control airspace violations during OIF and OEF.[3]

In contrast, all current Air Force UA operators are aviators with flying experience that comes with the years of development and training in an environment that stresses compliance with rules and regulations regarding the operation of their aircraft. Because Army personnel constraints will not permit Army aviators to be the sole operators of Army UA, training for non-aviator UA operators must emphasize safety standards and the need for rules of engagement adherence.

Army culture is not an aviation culture but, because so many organic aviation assets will be organic to each BCT, commanders and UA operators need to be educated on and understand airspace and the importance of strictly adhering to airspace control guidance. This is fundamental to Army aviation operations because the primary conflict with Army UA below the CA involves Army helicopters and other UA. Adherence to airspace control guidance is necessary to provide a safe and effective airspace

environment and to allow the enhanced doctrine and procedures that accomplish it to work.

For the C2 piece, the ASOC currently manages airspace below the CA and will continue to have a role in airspace control when the roles and responsibilities of A2C2 increase. The key contributions of the A2C2 element at any echelon will be in executing its own mix of positive control and limited procedural control to ease the airspace management burden on the ASOC, increase the instances of sector control being delegated to A2C2, provide information to contribute to the COP, deconflict its UA to increase the safety factor of the JFC's airspace, and coordinate UA activities (when available) to reduce the stress on finite airspace.

Enhancement and expansion of Army aviation doctrine and procedures (to help resolve the airspace issues that increased proliferation of UA will generate) will only be successful if Army commanders support them. The BCT's emerging air capability comes with a host of new responsibilities and areas of domain knowledge with which an Army ground maneuver commander may not have any previous experience. In this case, he or she must support and maneuver in accordance with the advice and guidance that his or her A2C2 element provides. In addition, the A2C2 element and the BCT UA operator must embrace the third dimension, and strive to truly understand it, in order to operate in a safe and efficient manner among all the other joint users of the airspace.

Solutions for UA at All Altitudes

A combination of efforts must take place to fix the current and emerging airspace issues that increasing numbers of UA represent, as well as a new direction for DoD UA programs to avoid future issues with interoperability, cost, redundancy, and employment.

By increasing the capability of Army A2C2 elements through organization, training, and equipment, a comprehensive low-level air picture can be provided to allow the joint force the risk mitigation and situational awareness it requires below the CA. A2C2 must have the organic capability to provide this picture and a commensurate level of C2 before the JFACC can doctrinally grant sector control to the Army commander operating in a joint environment. Sector control by an enabled A2C2 element utilizing increased positive control measures is truly the way to allow Army maneuver commanders the freedom of action they require while ensuring the JFACC that airspace control within that Army commander's AO will not suffer.

Looking further into the future and to military UA in general that operate both above and below the CA, the joint force must have a process by which to streamline and maximize the UA process. Without it, the Services will likely continue a down stove-piped track of single-service requirements, procurement, and operations for its particular UA. This option will only further complicate joint airspace while simultaneously neglecting the inherent benefits that jointness brings.

Taking the Lead

The tendency of individual Services to develop and resource their requirements while instituting operational procedures absent consideration of the other Services highlights the need for joint development, acquisition, and fielding of UA. Future UA production and fielding should be founded on the same principle of unity of effort that is critical in all joint operations and, perhaps even more so, to UA planning and execution. For the most part, the control, deconfliction, and coordination of UA are difficult tasks that are further complicated by a lack of interoperability. This situation is the result of the

Services operating under different UA concepts with different results in mind. A truly joint vision, which is already spelled out in broad terms by the DoD UAS Roadmap, must be embraced by all the Services, especially the Army and the Air Force, to maximize resources and help solve the issues associated with the UA boom.

Without joint UA cooperation from beginning to end, the joint force will guarantee a future of even more complicated and hazardous airspace which will inevitably lead to a lack of joint force flexibility and, ultimately, a reduction in the JFC's combat effectiveness. In this sense, the efforts to manage UA within the existing airspace architecture is an exercise in dealing with the symptoms of differing Service visions and with a lack of organic C2 structure to deal with these assets once they are fielded.

Recently, a proposal was made to the Secretary of Defense by the Air Force for it to be the executive agent for UA operating above 3,500 feet AGL. This proposal is the Air Force's effort to manage the requirements, development, and acquisition of larger DoD UA in order to maximize resources, capability, and interoperability. This proposal sparked a significant debate between the Army and the Air Force in the spring of 2007.

The Army opposes the bid because it views it as an Air Force attempt to gain control over its UA. In its view, this executive agency role would ultimately deny Army ground commanders with immediate access to its larger UA (Class III and IV). The Air Force contends that the intent of the executive agent is "to improve delivery of ISR information to America's joint warriors on the ground, sea, and in the air while increasing jointness and achieving resource efficiencies."[4] Lieutenant General David A. Deptula, Air Force Deputy Chief of Staff for ISR, went on to say that the executive agent would eliminate redundant efforts in areas like UA development, training, and logistics. UA that

operate above 3,500 feet AGL are referred to as medium to high altitude, and are the focus of the Air Force's executive agency bid.[5]

The Air Force's primary motivation behind executive agency is the responsibility to fight wars the best way possible. General Deptula said, "The individual Services do not fight wars. Rather a combatant command, headed by a JFC takes the capabilities that each Service provides and then applies them in an appropriate mix and fashion to accomplish the warfighting objectives." The Air Force's ultimate goal, he adds, is to "get medium- and high-altitude UAVs ISR distribution to be as transparent and joint as the Global Positioning System signal is to all of the Services. Global Positioning System is 100 percent owned and operated by the Air Force, yet its effect has become so ubiquitous that it is depended upon by all of the Services without any concern. We can do that with medium- and high-altitude UAVs."[6]

The need for an executive agent, or for a method to provide jointness in the UA process, has been identified and called for by the Government Accounting Office.[7] It specifically noted that the DoD "lacks a robust oversight framework and strategic plan to guide UAS development and investment decisions." Identification of the need at this level by other government agencies may ultimately mandate the establishment of an executive agent or, at a minimum, demand proof that the Services have a coherent strategic plan for their UA fleets and the multitude of issues related to them. The Air Force's core competencies as the nation's air and space power make it the most logical choice for this role but, regardless of who carries it out, the task of joint planning and oversight must be accomplished.

This issue will likely remain a point of contention for some time, but the Air Force's identification of the need to bring unity of effort from UA conception through UA employment is undeniable. Without this unity of effort, the joint force will continue to struggle with the symptoms of the problem because it is not treating the cause.

Implications for Failure

Failure to achieve this unity of effort from initial concept through UA employment will fall directly on the shoulders of the joint force, and the implications are significant. Turning back the clock on the progress that was achieved through the Goldwater-Nichols Act of 1986 would be the result of failing to cooperate and rely on the inherent Service strengths that each bring to the JFC.

A stove-piped approach to UA operations is not only a waste of resources, but it is also a recipe for failure which can come in many forms. The most obvious is crowded, chaotic airspace, while the most addressed is the perennial budget competition, but the most significant would be losing young Americans as the result of a midair collision. The potential for this tragedy certainly exists if the joint force fails to smartly control, deconflict, and coordinate UA operations. This potential grows as the military services continue to acquire dissimilar UA without a parallel acquisition effort to provide C2 for these assets.

This reality quickly leads to a risky scenario where the joint force is unable to provide the location and identification of its airborne assets. This condition will threaten the JFACC's ability to provide air superiority, a critical requirement that the joint force has grown used to and often takes for granted. If the JFACC cannot identify everything in the JFC's airspace, the JFACC cannot protect the force via air superiority.

Final Thought

Airspace is a joint medium that belongs to all members of the joint force. Indeed, all Services and components require access to it in order to accomplish their missions. Airspace transcends definitions of being strategic, operational, or tactical. Unlike ground AOs, it cannot be dissected into various portions that a given Service or component will "own." Airspace must be accessed by multiple users, so the notion of dissecting it and assigning ownership is impractical and unfeasible.

Deconfliction within the airspace is certainly a prerequisite for successful joint air operations and remains a significant issue for the joint force, but it should not be the ultimate purpose of the efforts to manage joint airspace. Mere deconfliction alone is defeatist, an incomplete solution, and does not stress the maximization of the airspace to accomplish the JFC's objectives. If not managed properly, UA threaten the joint force by degenerating into reactive attempts to simply provide deconfliction instead of striving to take full advantage of the third dimension's potential by effective coordination and control of all airborne assets.

The future of UA operations is certain. They are here to stay, and will continue to provide vital combat capability to the joint force. To enable that capability, the joint force must ensure that its doctrine and procedures require the Services to organize, train, and equip its units to provide the necessary C2 for its assets and to collectively make the future of UA operations a success story characterized by the unity of effort that makes it so strong.

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[1]Neuenswander.

[2]Ibid.

[3]Ibid.

[4]Lieutenant General David A. Deptula, USAF, Deputy Chief of Staff for Intelligence, Surveillance and Reconnaissance. Statement to the House Armed Services Committee. 19 April 2007; available from http://dailyreport.afa.org/NR/rdonlyres/55090D56-800B-4C31-9F87-4C14FB899FDD/0/041907Deptula.pdf; Internet; accessed on 22 April 2007.

[5]Ibid.

[6]Ibid.

[7]U.S. Government Accountability Office, GAO-06-610T, 4.

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